

**A.O. SMITH**  
**WATER PRODUCTS**  
**COMPANY**

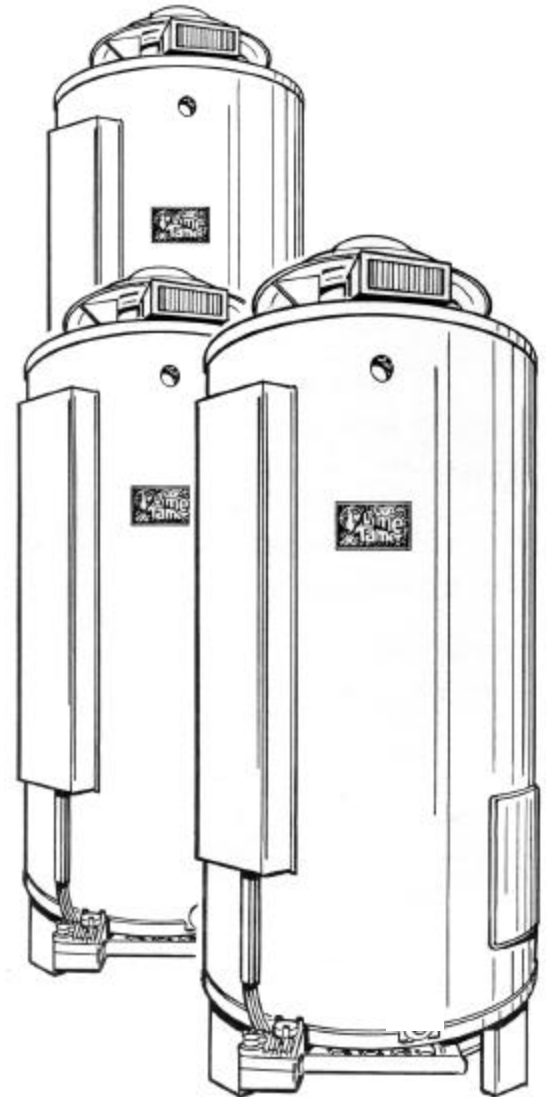
A DIVISION OF A. O. SMITH CORPORATION



# **BTC 120-500**

## **Service Workbook**

***Series 970 through 971***  
***(also converted 962-967 Series)***  
***Tank Type Heaters***  
***With Honeywell S8600M***  
***Ignition Systems***



This Service Workbook was prepared by:  
***The Training Department***  
***Irving, Texas***

**BTC TANK TYPE HEATERS  
SERVICE WORKBOOK**

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**BTC WORKBOOK  
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**BTC WORKBOOK INTRODUCTION**

This service workbook is designed to aid in servicing and troubleshooting A.O. Smith BTC water heaters in the field. No duplication or reproduction of this book may be made without the express written authorization of the A.O. Smith Water Products Company.

The following text and illustrations will provide you with a step by step procedure to verify proper installation, operation, and troubleshooting procedures. Additional quick reference data is included to assist you in servicing this product.

The information contained in this workbook is designed to answer commonly faced situations encountered in the operation of the BTC product line and is not meant to be all inclusive. If you are experiencing a problem not covered in this workbook, please contact the A.O. Smith Technical Information Department at 1-800-527-1953 or your local A.O. Smith Water Products Company representative for further assistance. This workbook is intended for use by licensed plumbing professionals and reference should be made to the installation manual accompanying the product. This workbook contains supplemental information to the BTC installation and operation manual.

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**Qualifications:** Installation or service of this water heater requires ability equivalent to that of a licensed tradesman in the field involved. Plumbing, venting and electrical testing skills are required.

**Tools Required:**

- Phillips head screw driver
- standard screw drivers
- a 3/8 and 7/16 inch open end wrench
- set of marked drill bits
- an electrical multimeter tester capable of measuring continuity
- gas pressure gauge or manometer
- water pressure gauge
- thermometer (range 0 - 220 degree F)
- 1/2 inch socket with extension for removal of the clean out cover,
- 1 1/8 inch socket with extension for anode removal.

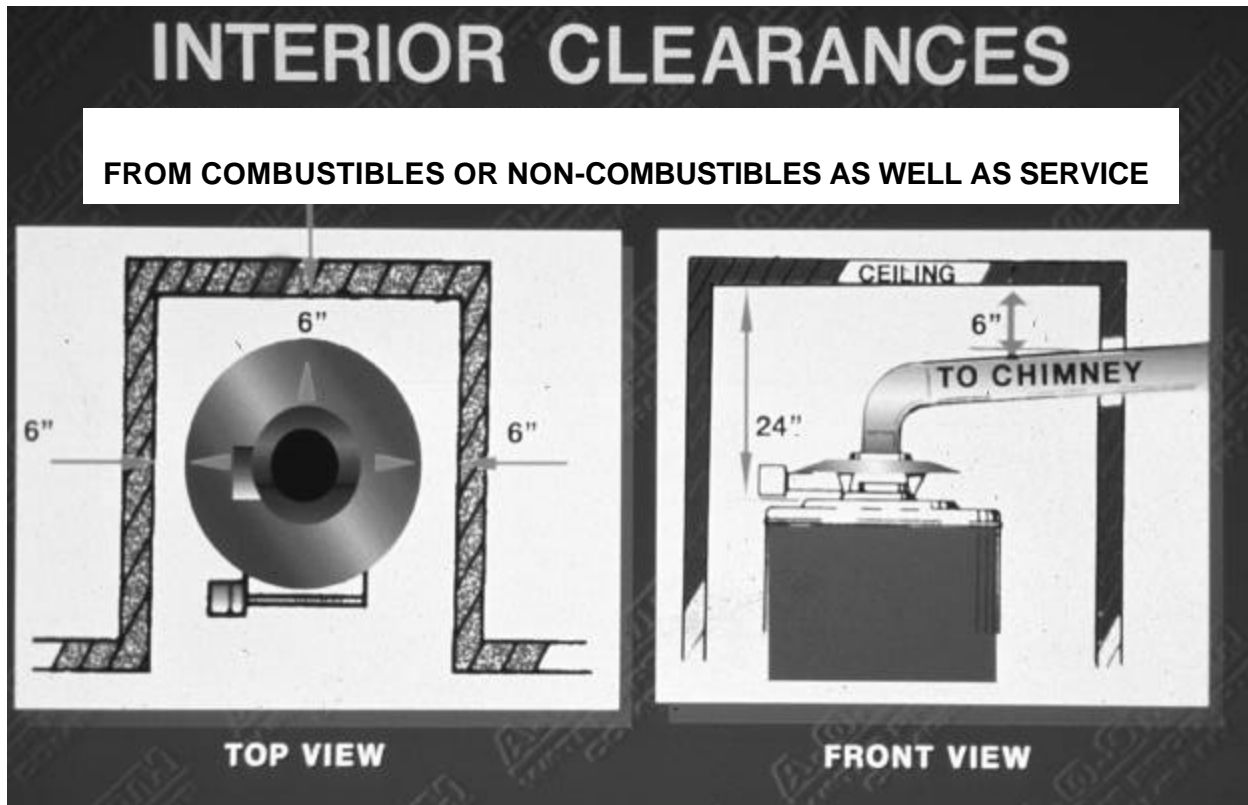
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### INSTALLATION

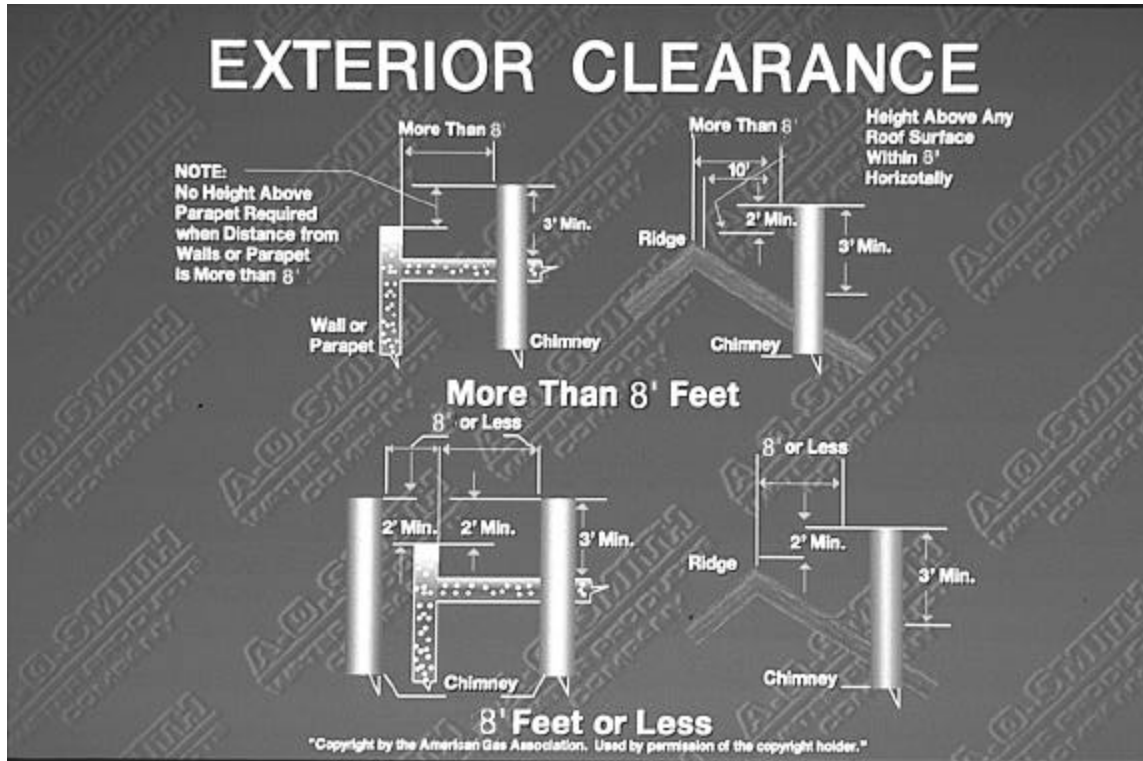
This portion of the workbook will review some often overlooked installation considerations, taking note of necessary installation requirements for the BTC 120-500 970 through 971 series heaters, and the BTC series 962-967 models which have been converted to Honeywell ignition systems. The installation manual covers most of these items in detail.

Note: For BTC models prior to 962 series, see troubleshooting manual TC-015.



BTC heaters are approved for installation on combustible flooring. Most can be installed in an alcove with minimum clearances to combustibles or non-combustibles of 6 inches from the sides and rear, 6 inches from any draft hood surface or vent piping, and 12 inches from the top cover. A 24 inch clearance for all serviceable parts is recommended. Clearances may vary between BTC models – See instruction manual or the label on the heater, for clearances applicable to your specific model.

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This illustrates the exterior roof clearances for BTC units with natural draft venting. The vent shall extend at least 3 feet above the highest point where it passes through a roof of a building, and at least 2 feet higher than any portion of a building within a horizontal distance of 8 feet (for vents of 12" in diameter or less). (NFPA 54 ANSI Z 223.1)

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Stoichiometric or theoretical complete combustion requires 10 cubic feet of air per 1000 BTUH input of the gas input. The National Fuel Gas Code also recommends an additional 2.5 cu.ft. of "excess" air. This 12.5 cu.ft minimum supply air per 1000 BTUH input applies to natural and propane gas models.

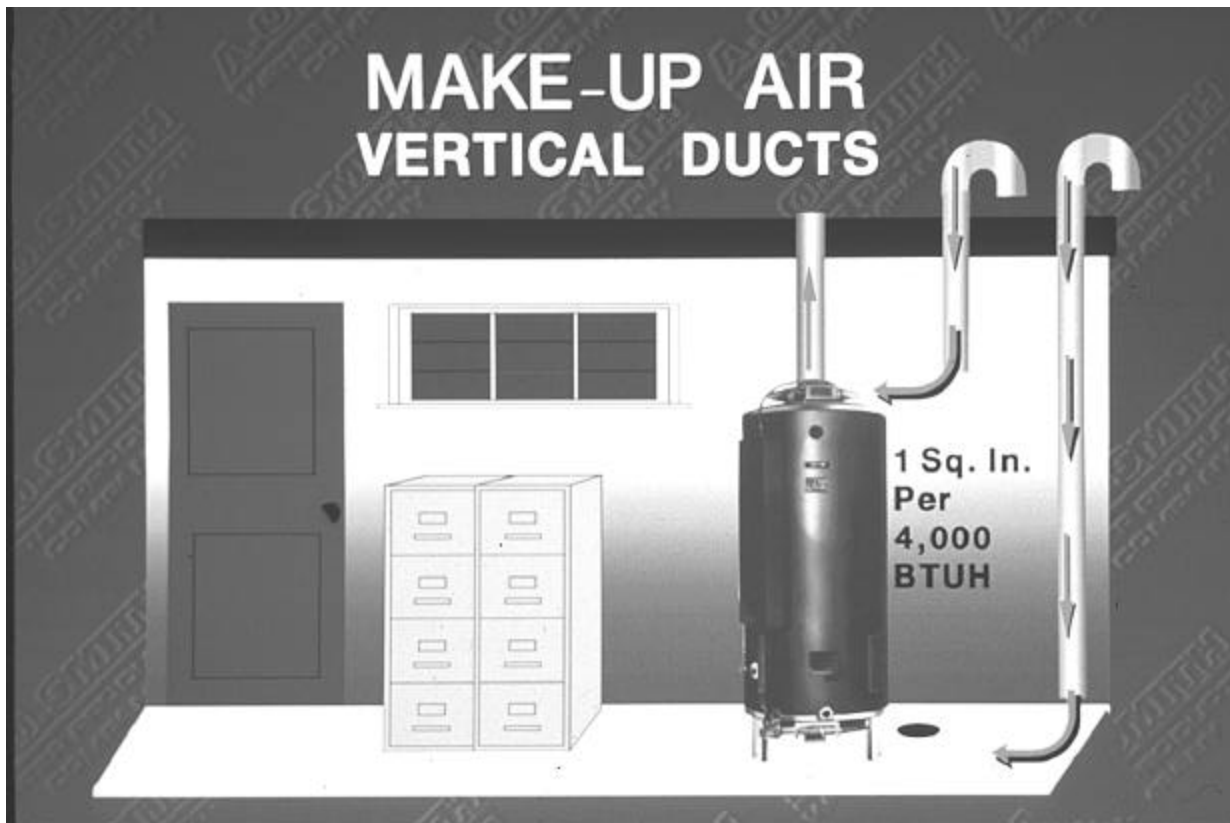
The National Fuel Gas Code also specifies minimum make-up air opening sizes for various building installations. (Ref: NFPA 54, ANSI Z223.1)



A fresh supply of make-up air for combustion can be supplied to the heater through make-up air ducts which directly communicate with the out of doors. Two openings are required - one within 12 inches of the top of the enclosure and one within twelve inches of the bottom of the enclosure. Each opening shall have a free area of not less than 1 square inch per 4000 BTUH of the total input of all appliances within the enclosure.

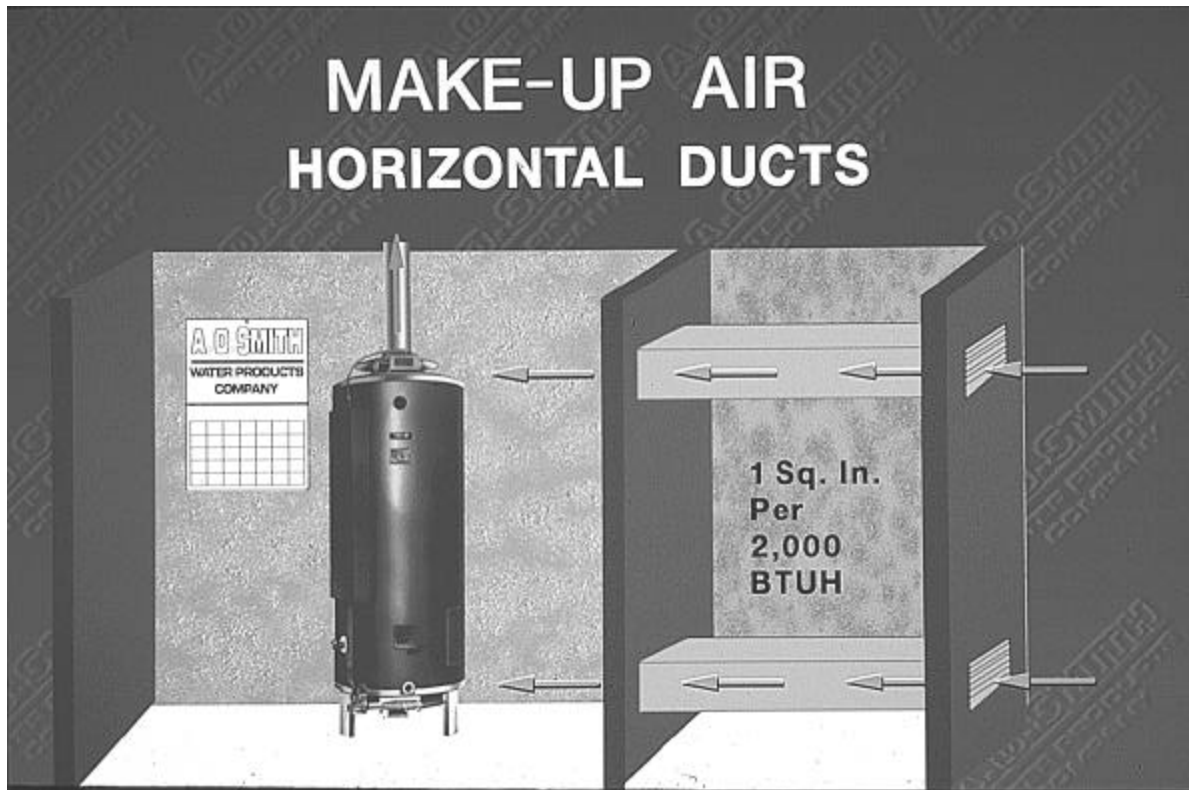
The lower opening is primarily providing combustion air. The upper opening is providing vent dilution air and acts as a relief opening for flue gases should the vent become obstructed or a downdraft condition occur. Additionally, when the heater is installed in a confined space and communicating with the outdoor air, one permanent opening, commencing within 12 in. (30 cm) of the top of the enclosure, shall be permitted where the equipment has clearances of at least 1 in. (2.5 cm) from the sides and back and 6 in. (16 cm) from the front of the appliance. The opening shall directly communicate with the outdoors and shall communicate through a vertical or horizontal duct to the outdoors or spaces (crawl or attic) that freely communicate with the outdoors, and shall have a minimum free area of:

- a. 1 sq. in. per 3000 BTU per hr ( $7 \text{ cm}^2$  per kW) of the total input of all equipment located in the enclosure, and
- b. Not less than the sum of the areas of all vent connectors in the confined space.

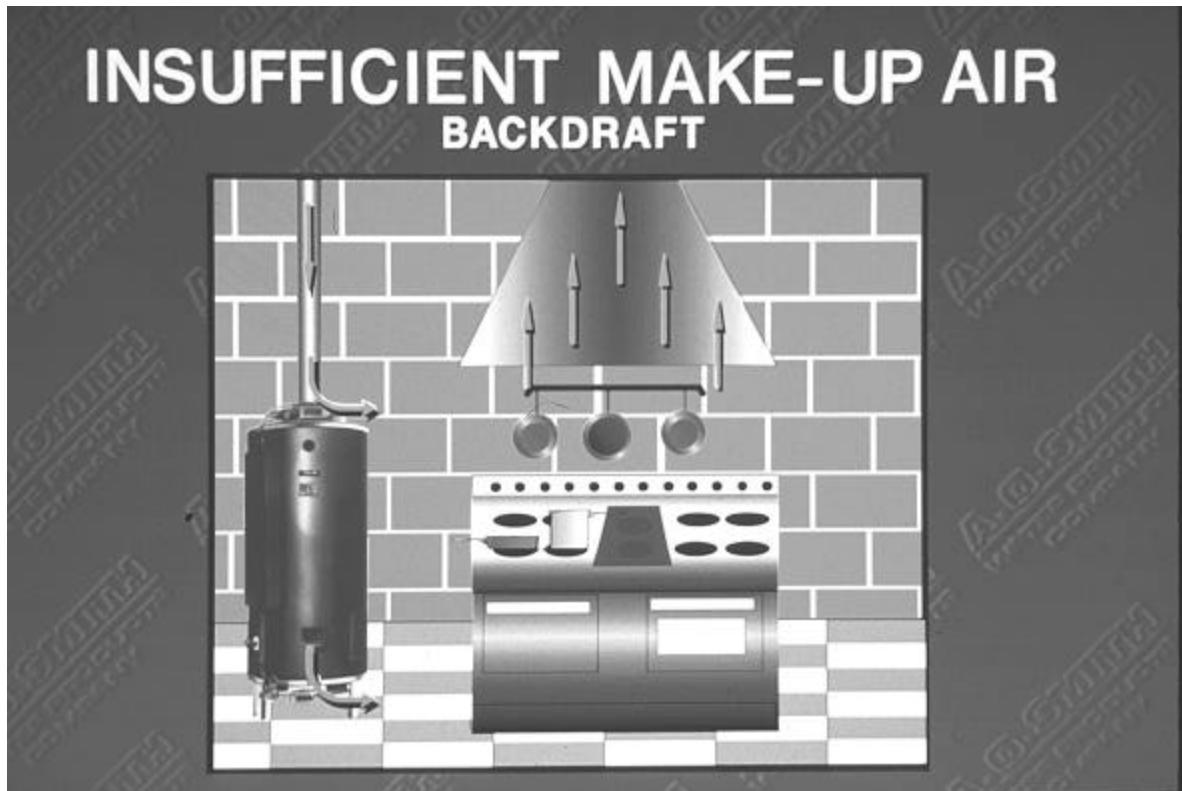


Often it is more practical to install vertical make-up air ducts to the out of doors. Again, two openings are required - one within 12 inches of the top of the enclosure and one within twelve inches of the bottom of the enclosure. Each opening shall have a free area of not less than 1 square inch per 4000 BTUH of the total input of all appliances within the enclosure.





When the heater is installed in an interior room with no roof access for vertical ducts, horizontal make-up air ducts should be installed. When using horizontal ducts, two openings are required - one within 12 inches of the top of the enclosure and one within twelve inches of the bottom of the enclosure. Each opening shall have a free area of not less than 1 square inch per 2000 BTUH of the total input of all appliances within the enclosure.



Insufficient make-up air is a major cause of combustion problems. One common example is in a restaurant installation where exhaust vent equipment was not considered in sizing make-up air requirements. This may result in air being backdrafted by the restaurant exhaust equipment through the heater causing flue gas spillage, flame roll out, improper combustion, inconsistent pilot operation, and/or erratic heater shut down.

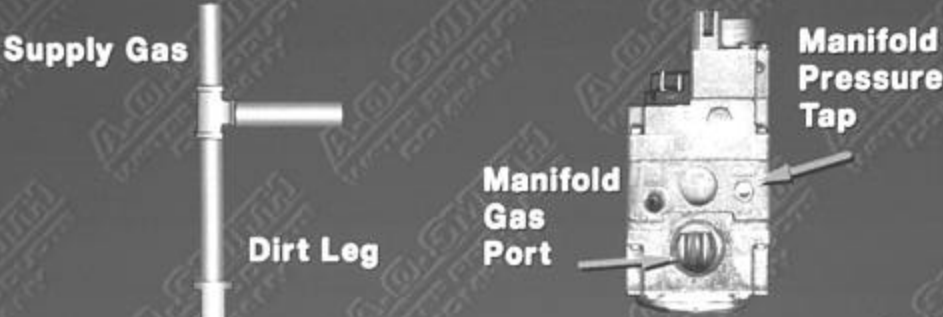


Along with adequate make-up air, the quality of the air is important. Contaminants in combustion air can lead to premature heater failure. Vapors from bleaches, soaps, waxes, salts, etc. are drawn into the combustion chamber with the make-up air and, once fired, mix with water vapor in the gases to form extremely corrosive hydrochloric or hydrofluoric acid and other corrosive byproducts.



Flammable items, pressurized containers or any other potentially hazardous articles must never be placed on or adjacent to the heater. Open containers of flammable material should not be stored or used in the same room with the heater.

## GAS PRESSURE REQUIREMENTS



The diagram illustrates the gas supply system for a tank type heater. On the left, a vertical pipe labeled 'Supply Gas' has a horizontal branch labeled 'Dirt Leg'. On the right, a gas valve manifold is shown with a 'Manifold Gas Port' and a 'Manifold Pressure Tap'.

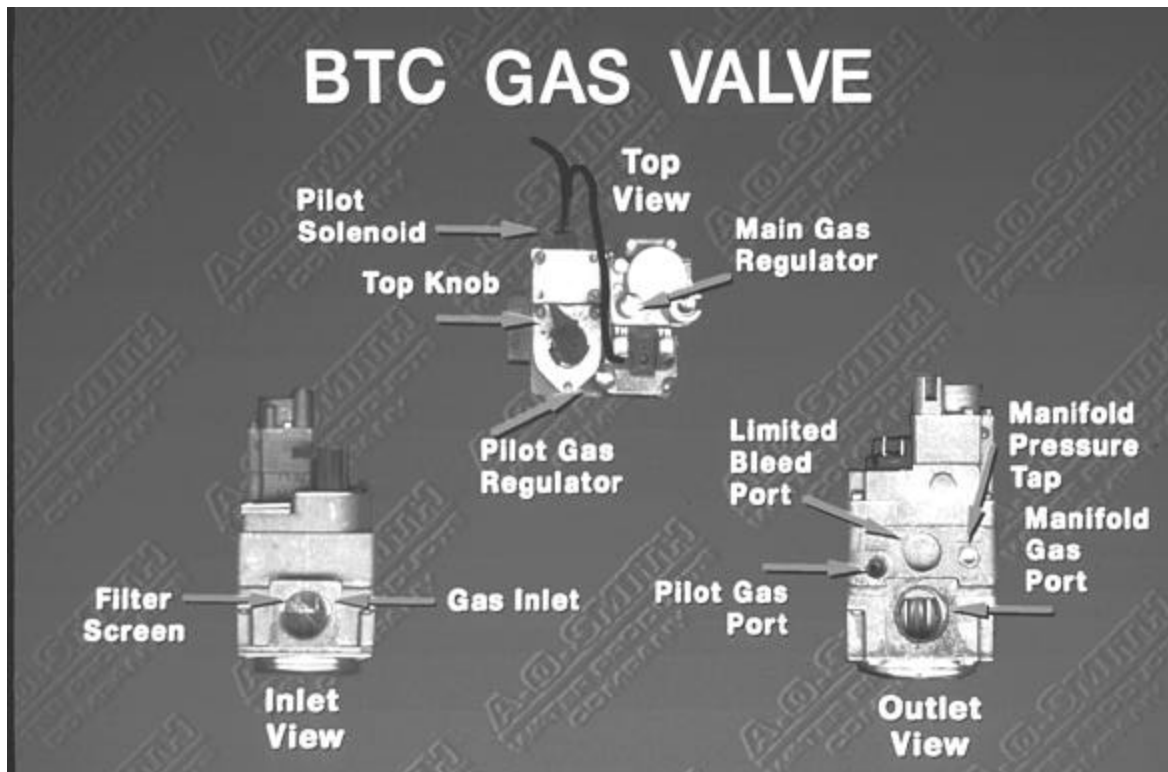
	Natural Gas	Propane Gas
Max. Supply Pressure	13.8" w.c.	13.8" w.c.
Min. Supply Pressure	4.5" w.c.	11" w.c.
Manifold Pressure	3.5" w.c.	10" w.c.

The supply gas pressure is normally measured at the dirt leg or at the gas pressure tapping on the gas supply shutoff valve. This reading must be measured with 'flowing' gas.

The manifold gas pressure is measured at the manifold pressure tap of the gas valve when the gas is flowing.

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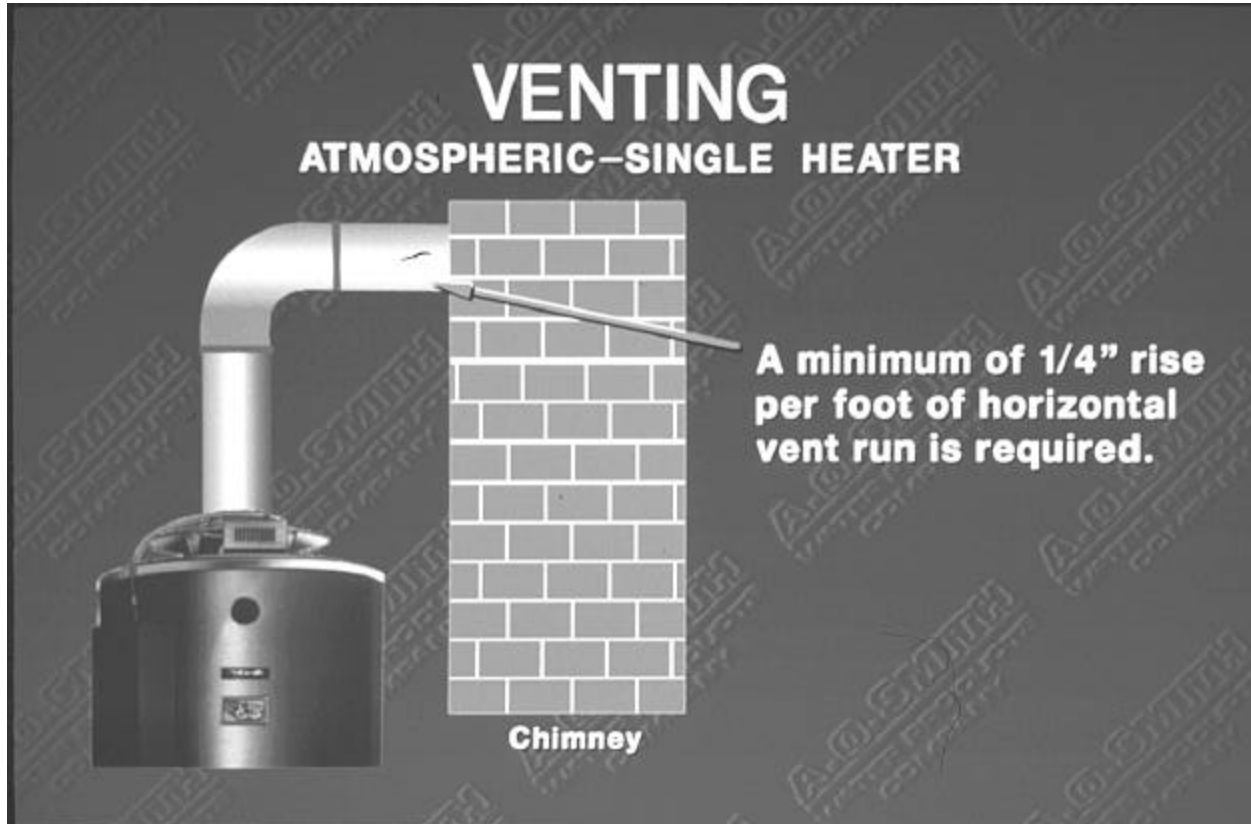


See page 38 for dual valve used on BTC-500 models.

The gas valves used on all BTC water heaters are 24 volt AC combination step opening gas valves. They incorporate the pilot valve, main valve, and gas pressure regulators into one body. The inlet view of the valve features a filter screen and pilot solenoid. On the outlet view of the gas valve, we see the pilot gas connection port, manifold gas connection port, a limited bleed vent port, and the manifold gas pressure tap.

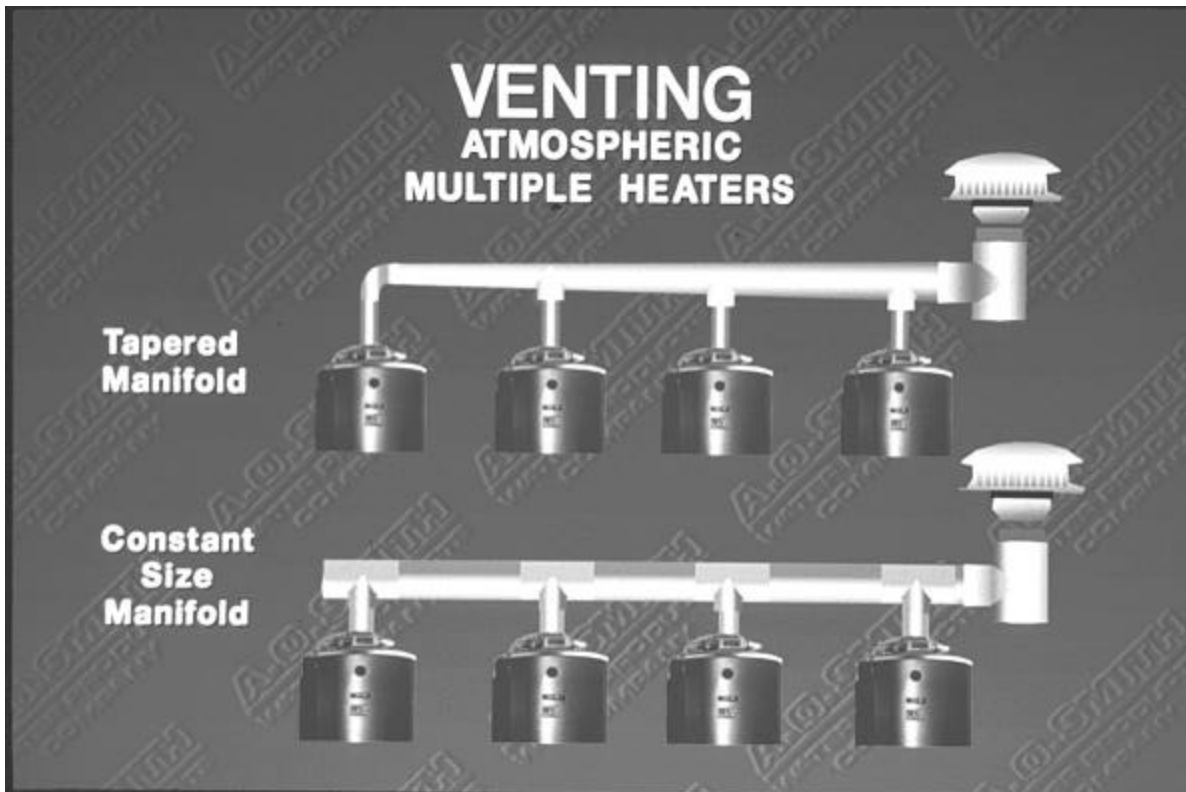
On the top view of the gas valve, we see the top knob which is a manual on/off gas control for both the pilot and main gas valves. When the top knob is placed on the black mark, gas is supplied only to the pilot valve. The pilot gas regulator is found under its cover screw. It is factory preset at 3.5" w.c. but can be adjusted from 2.5 to 5 inches water column. The main gas regulator is found under its cover screw. It is factory preset to 3.5 inches w.c. and adjusts gas pressure output from 2.5 to 5 inches water column.

The two electrical terminals are marked TH and TR. The TH terminal is the common between the pilot valve solenoid coil and the main valve solenoid coil. The other wire emerging from the pilot solenoid connects to the pilot valve electrical output on the IID (terminal PV). The TR terminal connects directly to the main valve electrical output from the IID module (terminal MV).



All BTC water heaters are classified by ANSI as category I (non-condensing, negative pressure venting) appliances. They are approved for type B vent.

BTCs may be common vented only with other category I appliances. (See venting section in the National Fuel Gas Code). This illustrates a single unit connected to a chimney. A minimum of 1/4 inch rise per foot of the horizontal vent piping is required.



For larger applications, BTC water heaters can be common vented together either in a tapered manifold or constant size manifold. (Follow National Fuel Gas Code requirements for sizing and installation.)



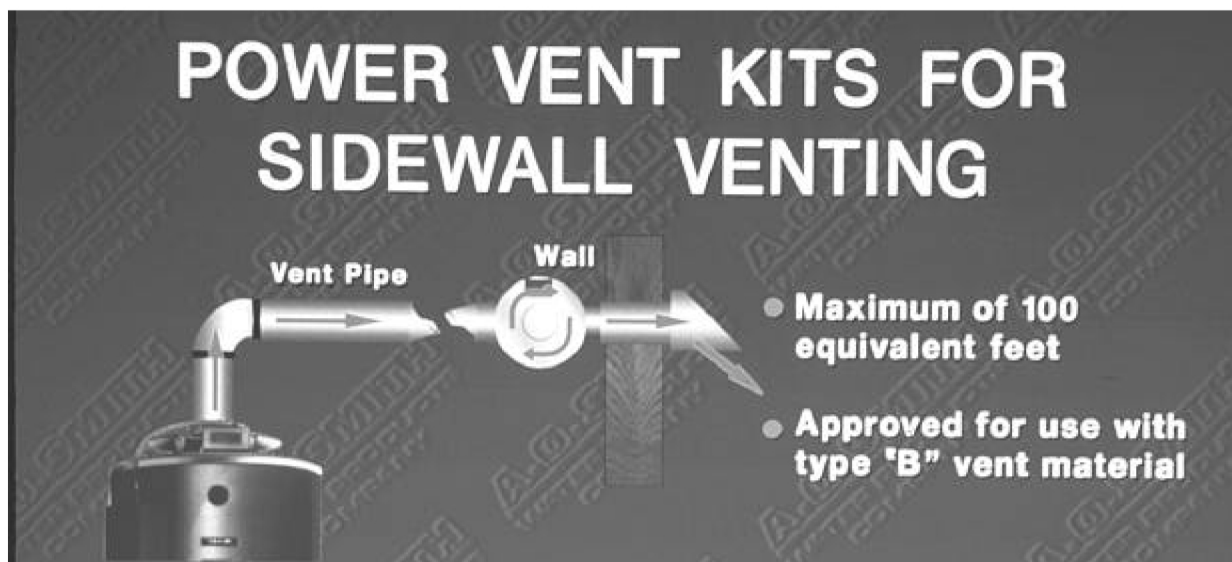


Draft inducers can be used with BTC water heaters to mechanically aid lazy chimneys in vertical vent applications. They are not designed to allow "through-the-wall" vent installations. (See Power Venter)

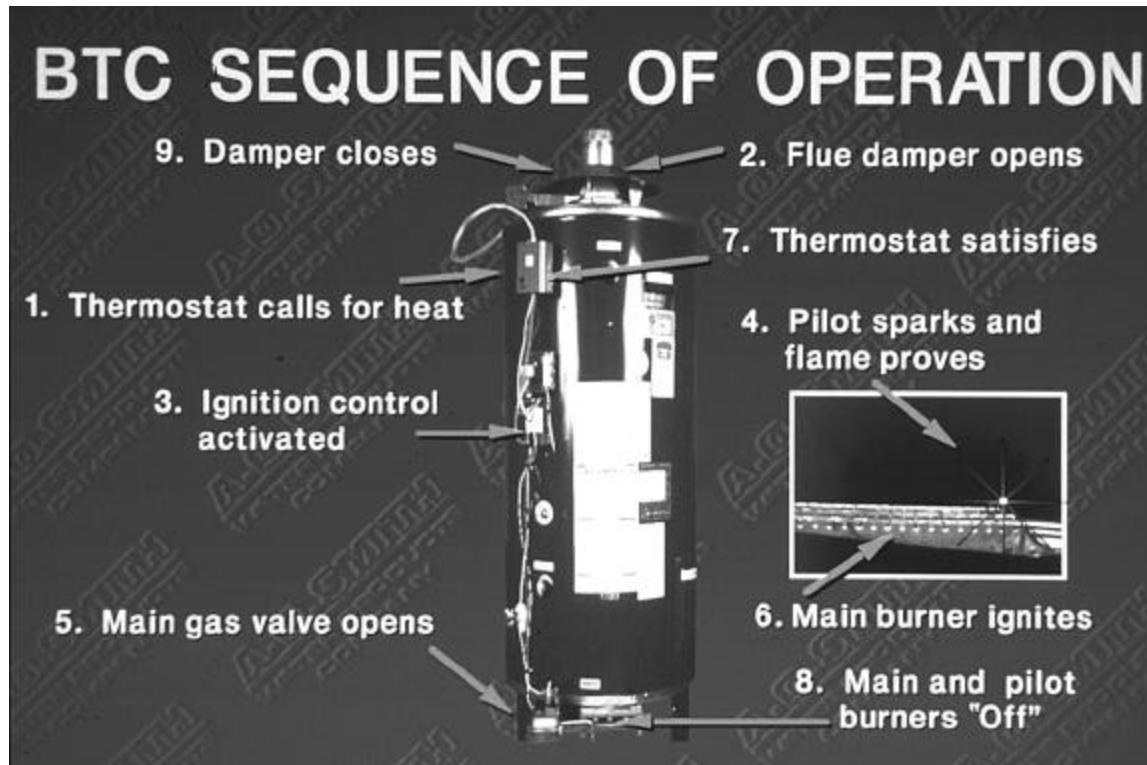
### **SINGLE UNIT INSTALLATION**

When mechanically venting, the following items are required:

Qty	Description
1	Draft Inducer (Up to 300,000 Btuh)
1	Draft Inducer (305,000 thru 500,000 Btuh)
1	Draft Prover Switch
1	Relay Switch



BTC water heaters can be used with power vent kits for sidewall venting. A.O.Smith offers power vent kits for use on installations with a maximum of 80 equivalent feet of vent piping. The power vent kits also use type B vent materials. When power venting, specific exterior clearances must be maintained, as outlined in the National Fuel Gas Code. (NFPA 54, ANSI Z223.1, sec 7.8)

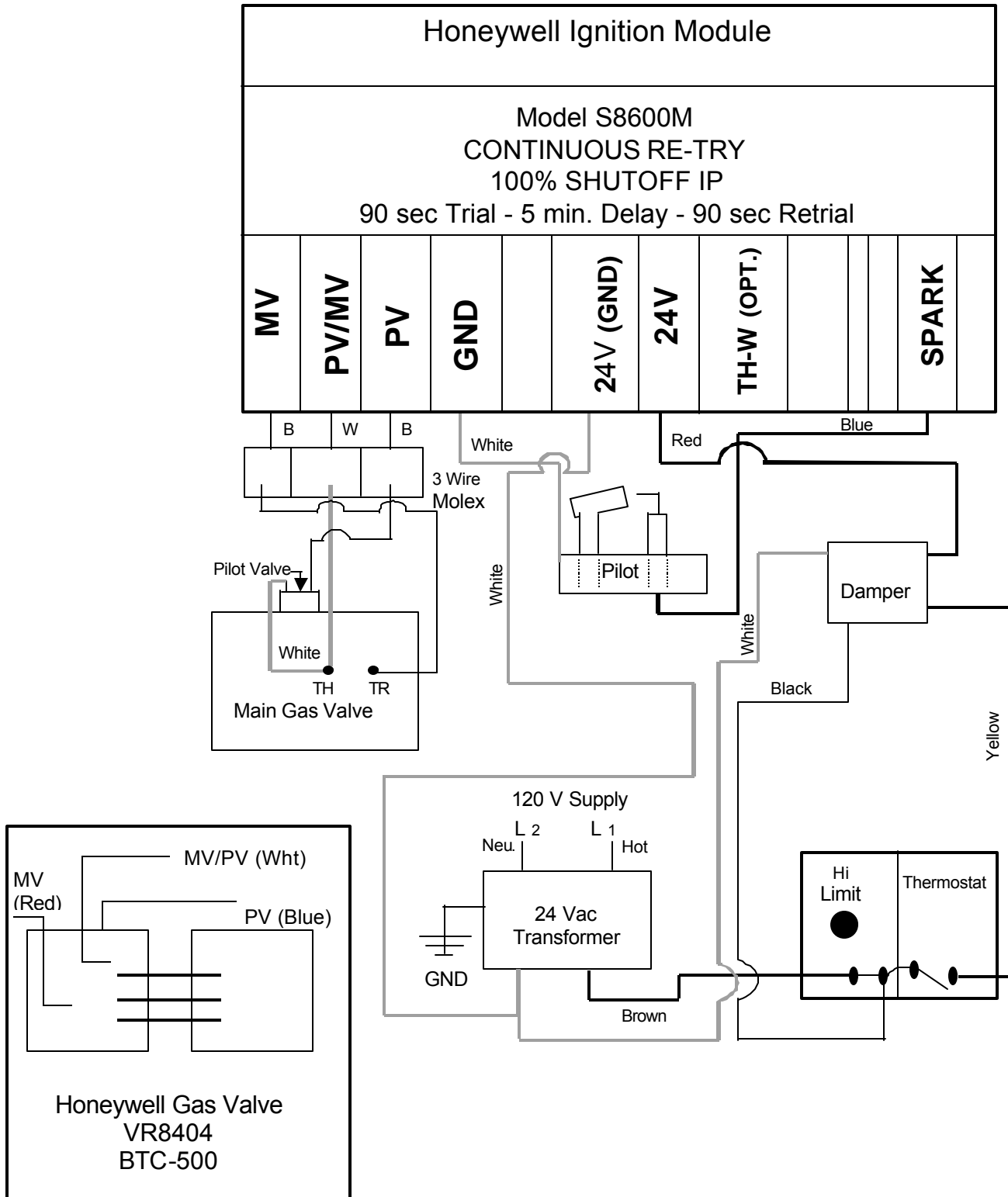


### SEQUENCE OF OPERATION

To understand BTC tank type water heaters, an examination of their sequence of operation is necessary.

When the thermostat calls for heat, the relay in the draft hood assembly activates, de-energizing the flue damper motor. The damper opens and power flows to the IID (Intermittent Ignition Device). This activates the IID module to open the pilot valve and begin sparking at the pilot burner assembly. Once the pilot flame is established and confirmed back to the IID by the flame sensor, the sparking is stopped and the main gas valve is opened, allowing gas flow to the main burner.

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## **BTC TANK TYPE HEATERS SERVICE WORKBOOK**

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### Electrical Sequence of Operation

This wiring diagram illustrates the automatic flue damper and electronic spark ignition system on BTC commercial gas water heaters. 120 VAC power enters the electrical junction box on L1 and L2 and is connected to a 24 VAC transformer. The neutral leg of the 24 VAC transformer is connected to the 24V (GND) on the IID and the common on the draft hood. The pilot valve solenoid and main valve solenoid are grounded to the module PV/MV terminal. The pilot is grounded to the module "GND" terminal.

The hot leg of the 24 VAC transformer is connected to the IID terminal TH through the draft hood via the ECO and thermostat, powering the flue damper motor, keeping the damper closed.

When the thermostat calls for heat, 24 VAC is sent through the thermostat to the draft hood, energizing the relay coil. When energized, the relay interrupts power to the flue damper motor and sends power to the end switch. A spring in the damper assembly rotates the flue damper to the open position.

When fully open, the damper closes the contacts in the end switch, sending power to terminal 24V of the IID, completing the circuit and activating the IID.

When activated, the IID sends 24 VAC to terminal PV (energizing the normally closed pilot gas solenoid valve), and also sends a 10,000 volt spark down the ignition wire to the pilot burner. The spark ignites the pilot gas and establishes a pilot flame.

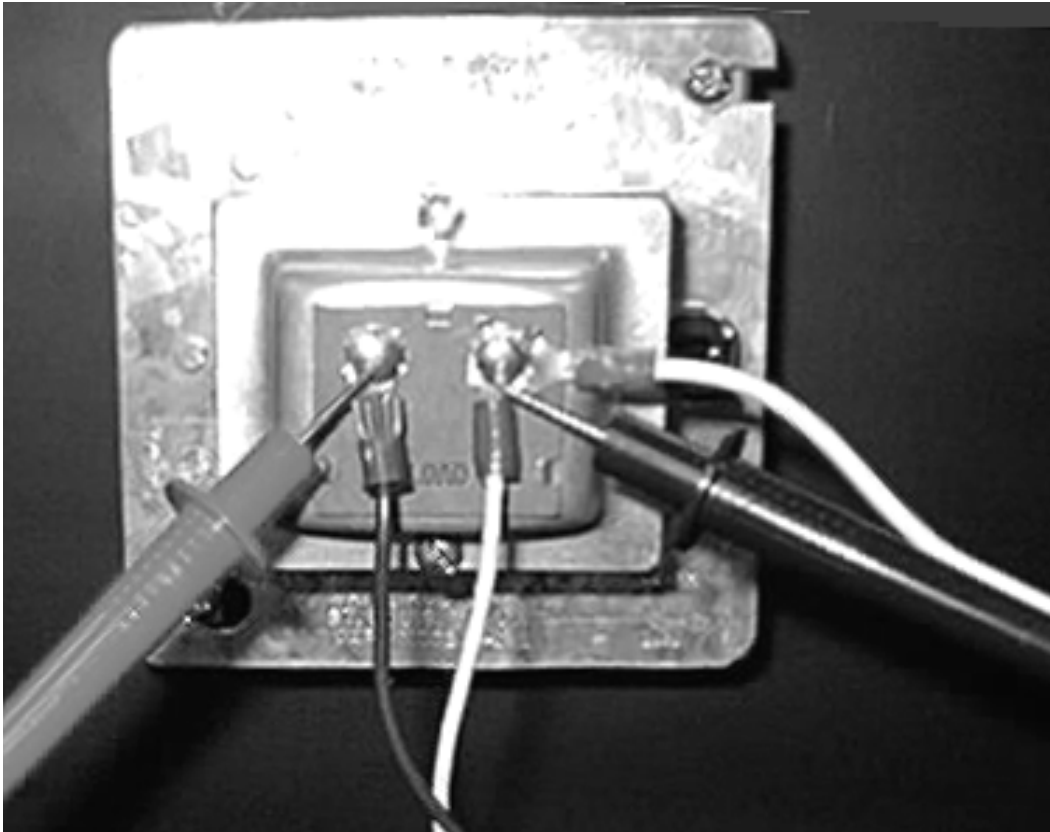
The pilot flame induces a flame rectification signal, which is returned back to the IID through the igniter and ground wires, proving the pilot. When the proven pilot signal is received, the sparking is switched off and 24 VAC is sent to IID terminal MV, powering the normally closed main gas valve solenoid. The main gas valve opens and the pilot ignites the main burner.

When the temperature of the water in the tank equals the temperature set on the thermostat, the contacts in the thermostat open, interrupting power, shutting down the system.

## **TROUBLESHOOTING BTC WATER HEATERS**

To troubleshoot a BTC water heater check that:

- 120 VAC is supplied to the heater
- the tank is full of water
- gas is supplied to the unit

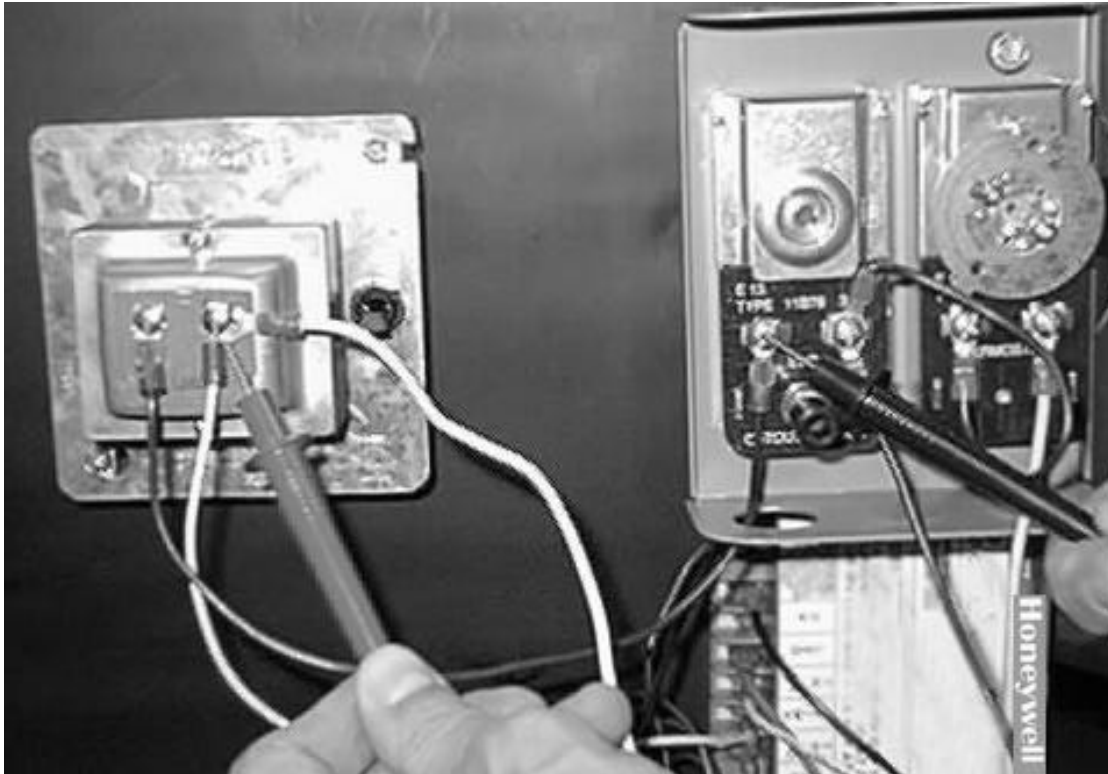


**STEP 1 TO TEST THE TRANSFORMER**, using a multimeter, test for 24VAC between the secondary transformer terminals.

- If the meter does not read 24 VAC, check the 120 VAC connections and retest. If still no 24 VAC, replace transformer.
- If the meter reads 24 VAC, go to Step 2.

## BTC TANK TYPE HEATERS SERVICE WORKBOOK

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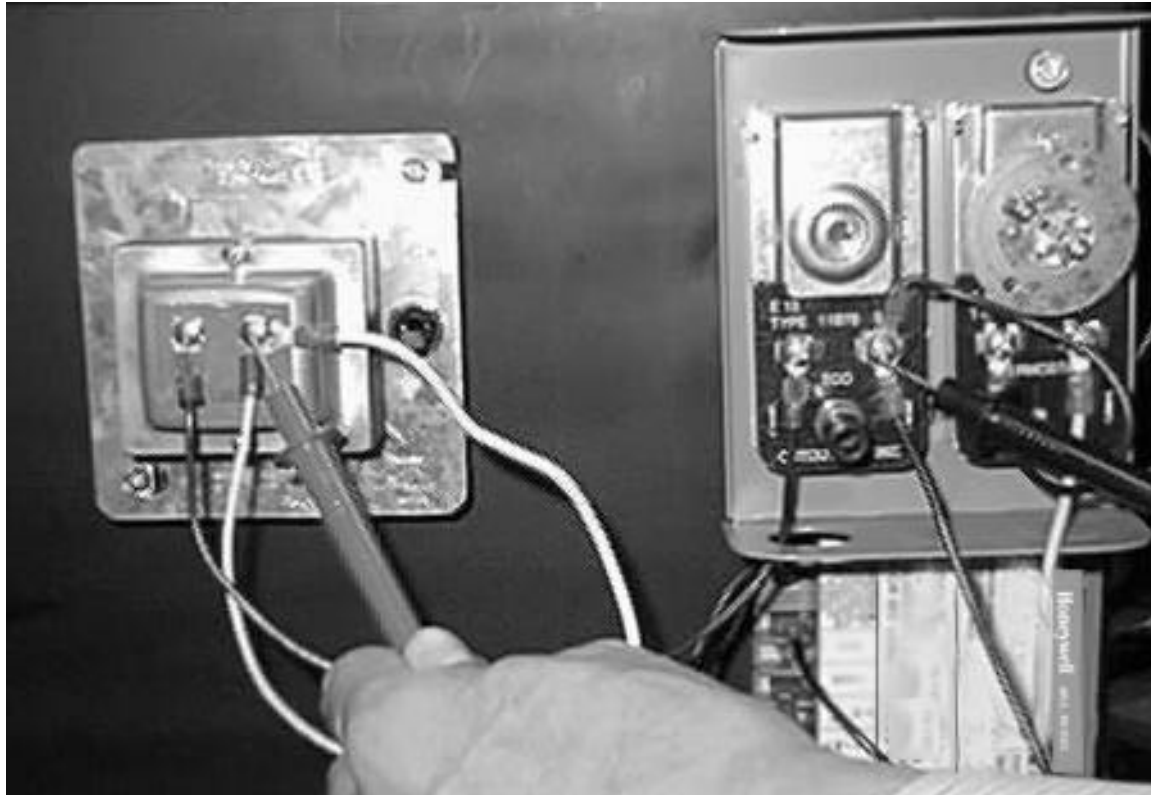
**STEP 2. HIGH LIMIT, LEFT TERMINAL TEST.** Test for 24 VAC between the left high limit terminal and ground.

- If the meter does not read 24 VAC, check wiring between transformer and high limit.
- If the meter reads 24 VAC, go to Step 3.

**Note:** The high limit (Energy Cut Off) opens if the tank water temperature exceeds 205 degrees. The control is resettable (manually) when the tank water temperature drops below 185 degrees.

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**STEP 3. TO TEST HIGH LIMIT RIGHT TERMINAL** , Ensure that the jumper wire between the high limit and thermostat is connected, and the damper motor power line is connected. Test for 24 VAC between the high limit right terminal and ground.

- If the meter does not read 24 VAC push the reset button and redo the test (storage water temperature below 185 degrees).

24 VAC is now present		
Reasons For Resetting		
Condition	Cause	Solution
High limit open	Never set on initial installation	Push high limit button
Excessive water temperature	Faulty thermostat	Replace dual control
Heater shut down before reaching thermostat setting	Faulty high limit	Replace dual control

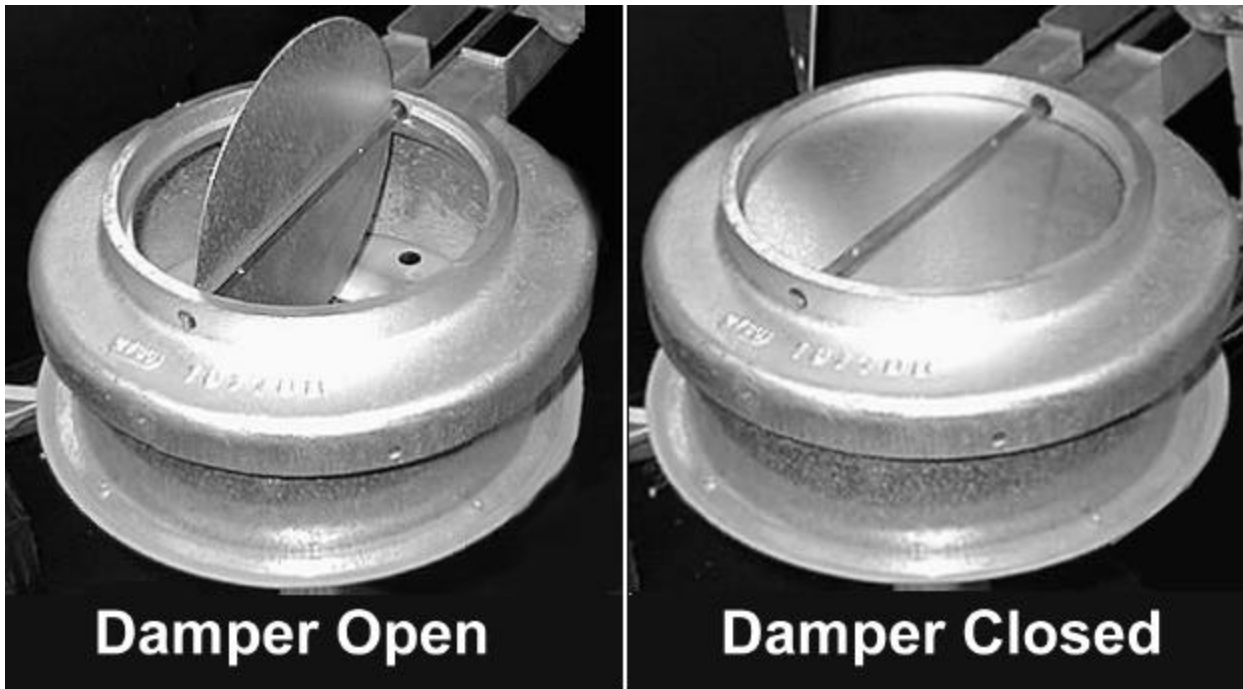
- If the meter reads 24 VAC, go to step 4.

**Note:** The right terminal of the high limit has a jumper wire connected to the left terminal of the thermostat. There is also a black wire connecting to the damper motor assembly. This black wire supplies power to the motor to close the damper during periods of standby.



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**STEP 4. INSPECT THE DAMPER.** Lower the thermostat setting so the unit will not be calling for heat, then inspect the damper.

- If the damper is open, go to step 5.
- If the damper is closed, go to step 7.

**Note:** *If the water temperature in the tank is below 120 degrees F, disconnect the jumper wire between the high limit and thermostat to simulate a satisfied thermostat.*

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**STEP 5. CHECK THE PC BOARD.** Test for 24 VAC between the black PC board wire connection and ground.

- If 24 VAC is not present, check the black wire connections between the PC board and high limit.
- If 24 VAC is present, go to Step 6.

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**Momentary Push**

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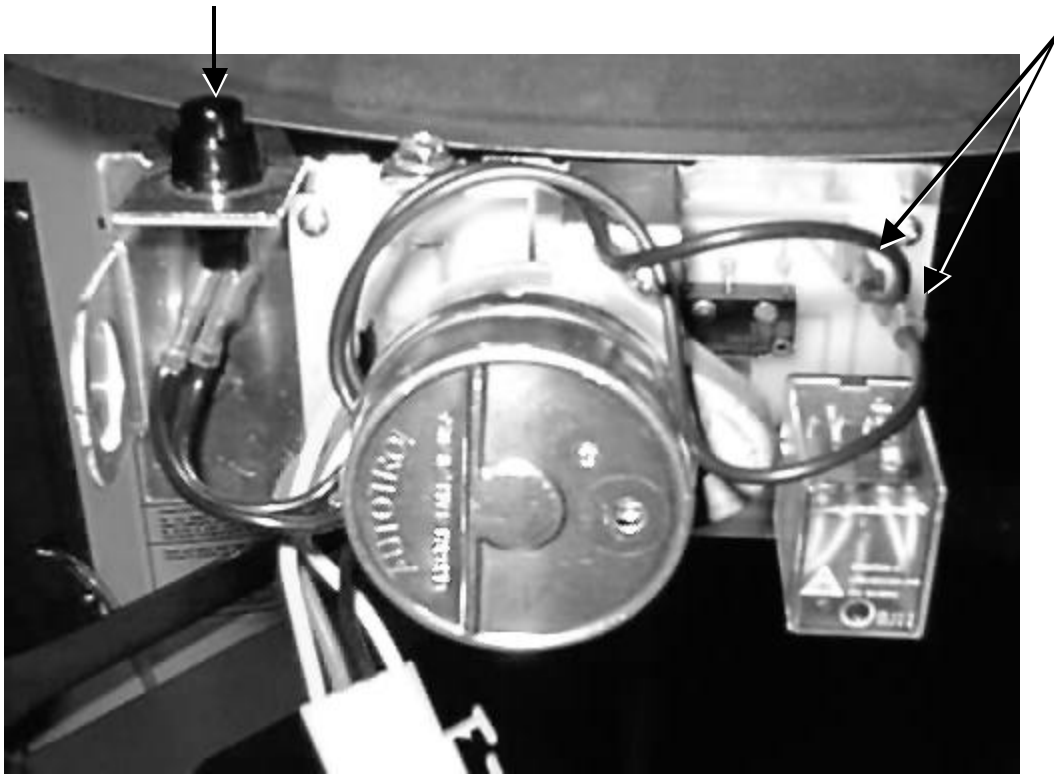
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**Motor Lead**

Terminals  
Workbook  
Training Department

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**STEP 6. PC BOARD/MOTOR TEST.** Check for 24 VAC between the two motor lead terminals of the PC board. Disconnect the wires for this test.

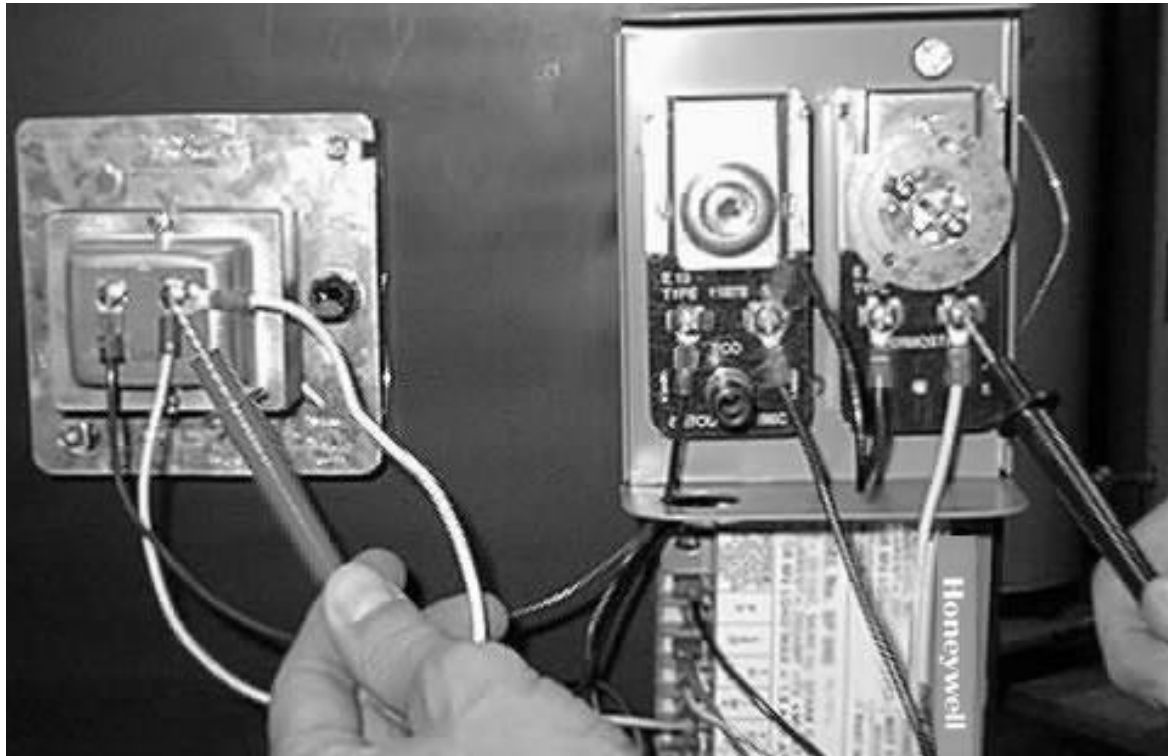
- If 24 VAC is not present, replace the board (AOS Part # 6522) and go to step 7. The board and relay are one piece. Regardless of which part is defective, both parts would be changed.
- If voltage is present, this verifies that the motor is receiving power but not closing the damper. Replace the motor (AOS Part # 6521) and go to step 7.

**Note:** The "momentary push button" service switch may be used to provide single heating cycles, while waiting for a replacement part.

**WARNING** - In the event of damper motor failure, verify that the damper is in the "open" position before utilizing the momentary push button service switch.

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**STEP 7. THERMOSTAT TEST.** Set the thermostat to call for heat. Using your multimeter, test for 24 VAC between right terminal and ground.

- If the meter does not read 24 VAC and the jumper wire between the high limit and the thermostat is in place, replace the thermostat.
- If the meter reads 24 VAC, go to Step 8.

**Note:** If the high limit to thermostat jumper wire was disconnected earlier to simulate a satisfied thermostat, reconnect the jumper to the terminals.

**Note:** A yellow wire from this thermostat terminal connects to the damper PC board.

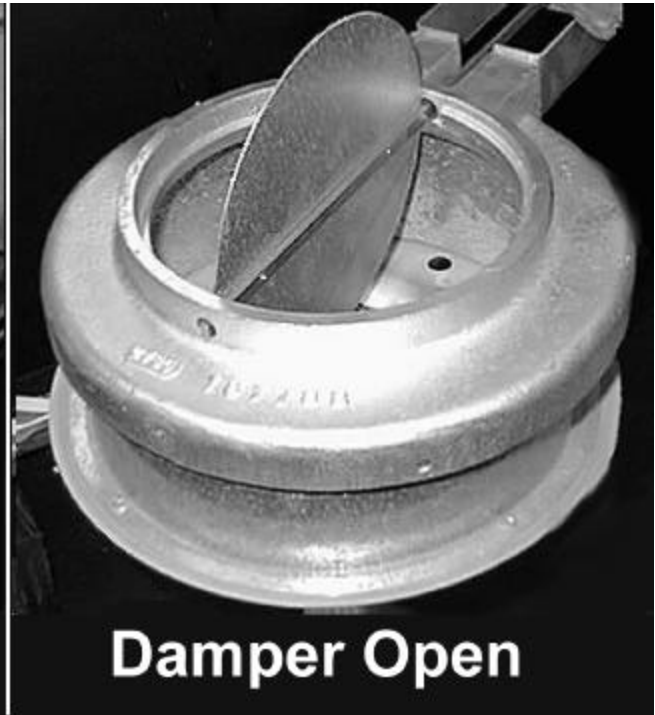
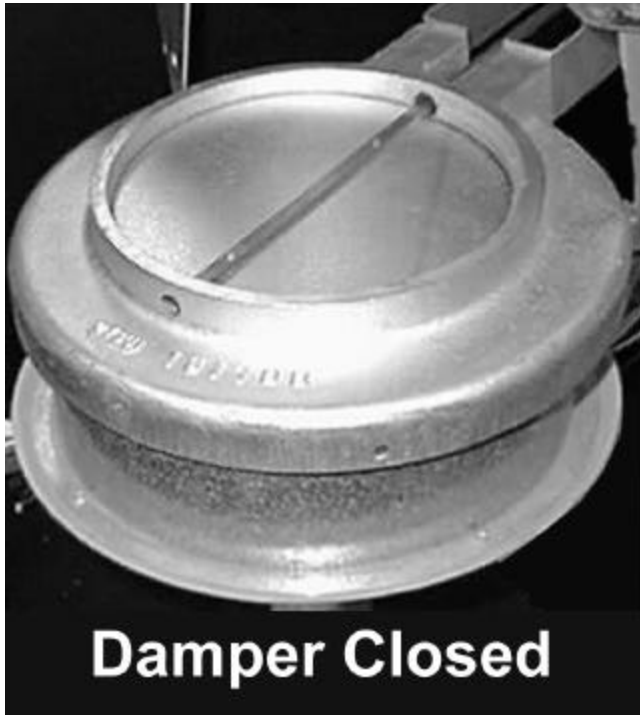


**STEP 8. DAMPER INPUT TEST.** Test for 24 VAC between the yellow wire on the PC board and ground.

- If the meter does not read 24 VAC and you have checked the wire and plug connections, then replace the wiring harness.
- If the meter does read 24 VAC, go to Step 9.

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**STEP 9. TO TEST THE DAMPER**, visually check the damper blade position.

- If the damper does NOT open fully, replace the damper assembly.
- If the damper DOES open fully, go to step 10.



**STEP 10. TO TEST DAMPER OUTPUT** - on a call for heat. The damper receives power through the yellow wire, the damper opens and proves it is open via an end switch before power flows through the red wire from the PC board.

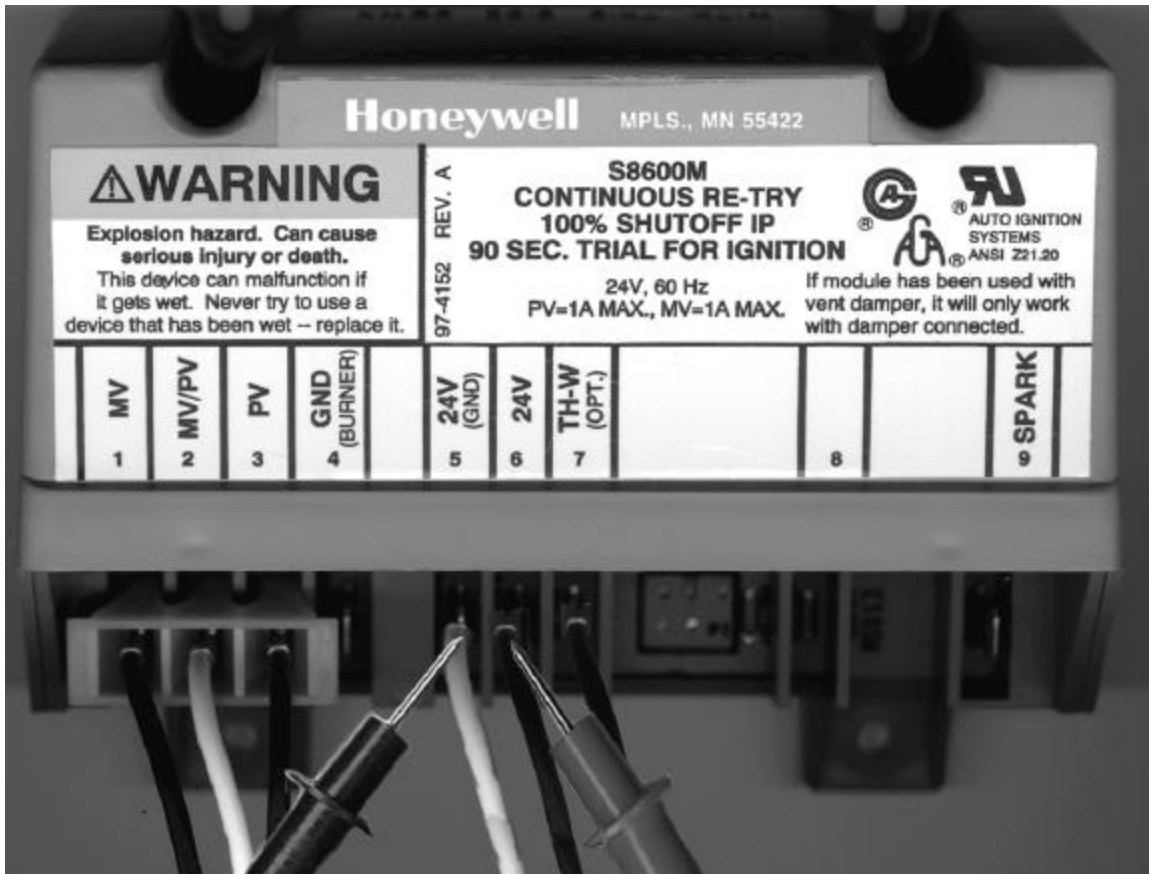
Place the red test probe on the solder joint of the red wire connection to the damper PC board.

- If the meter does not read 24 VAC, replace the PC board.
- If the meter reads 24 VAC, go to step 11.

**Note:** *The spring rotates the damper blade assembly to the open position. This closes an end switch.*

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**STEP 11. WIRE HARNESS TEST.** Test for 24 VAC between terminal 24V on the IID module, and 24V (GND).

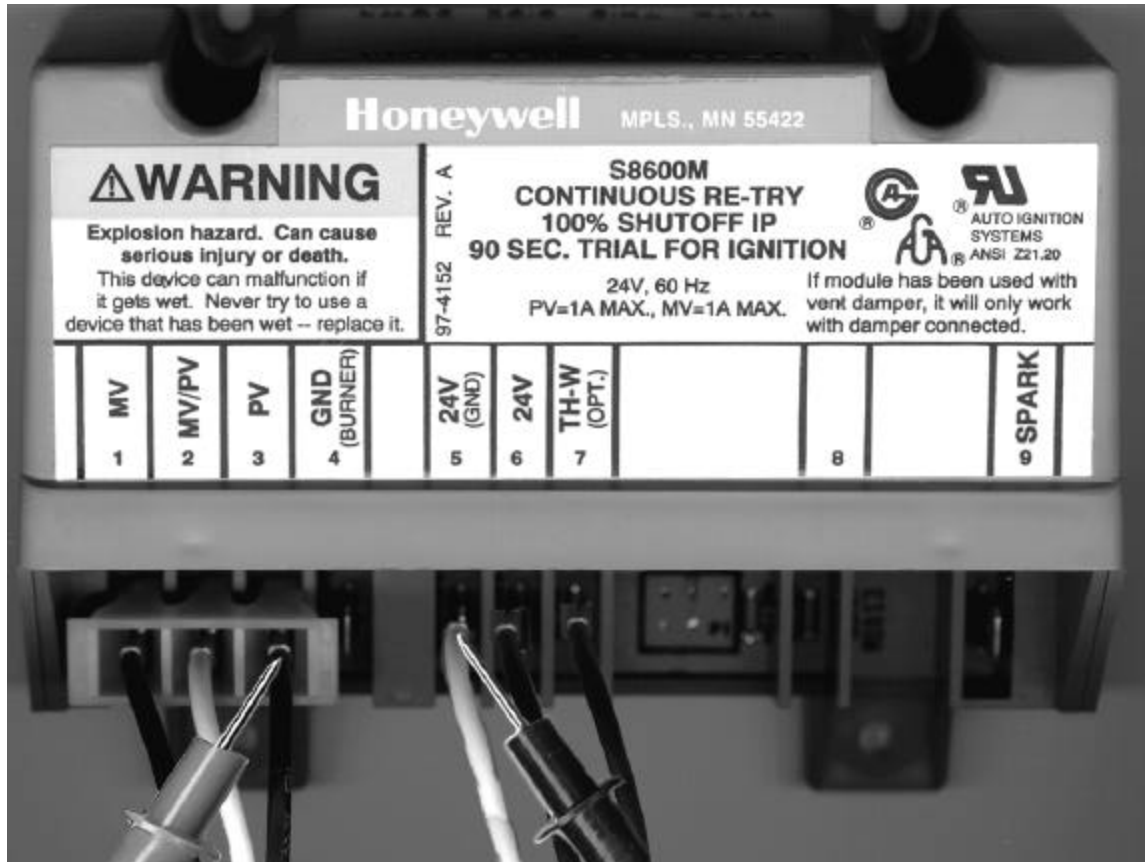
- If 24 VAC is not present, check the wiring harness.
- If 24 VAC is present, reconnect the red wire to terminal 24V on the IID module and go to Step 12.

**Note:** This test may be easier to conduct by removing the red wire from the IID terminal. Test for 24 VAC between the red wire and ground. Reconnect the red wire to the 24V terminal after the test.



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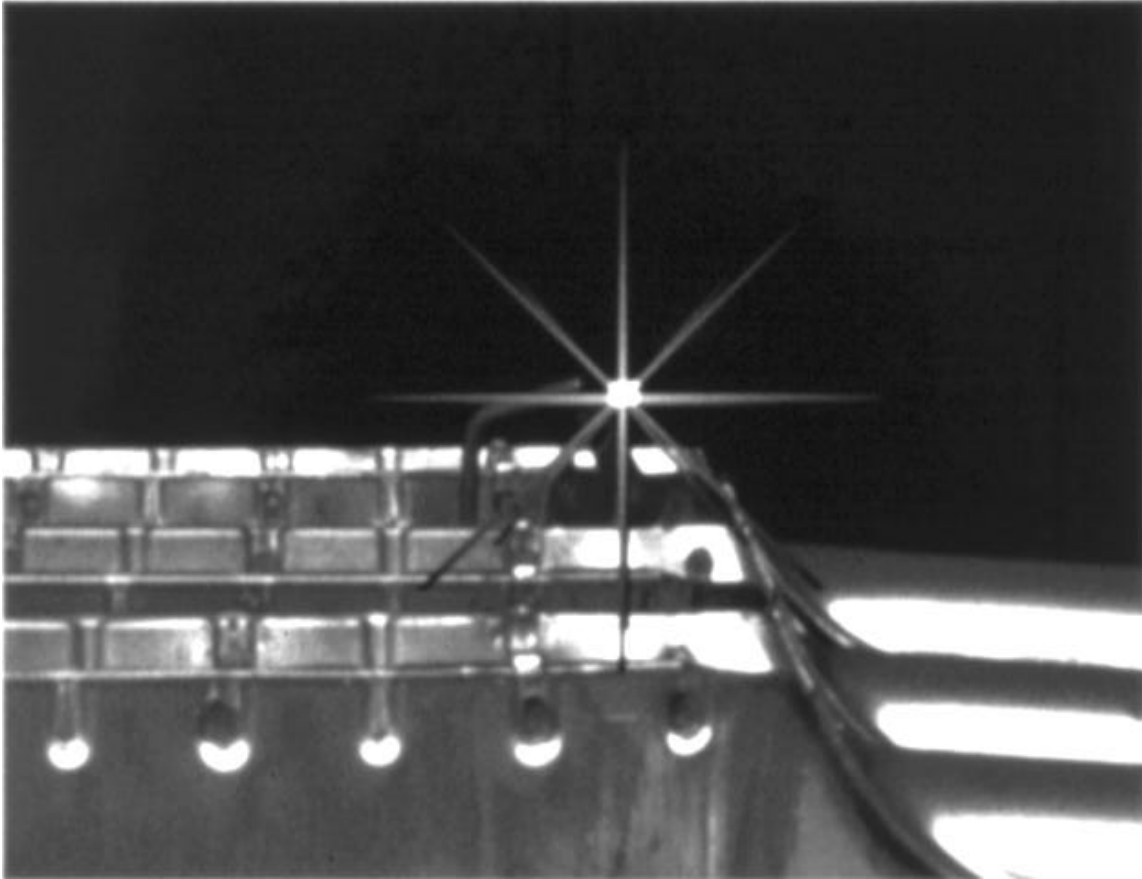


**STEP 12. IID MODULE TEST.** Using a multimeter, test for 24 VAC between terminal PV and 24V (GND) on the IID during the 90 second trial for ignition.

- If the meter does not read 24 VAC and the IID module is not between ignition trials, then replace the module.
- If the meter does read 24 VAC, go to Step 13.

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### **STEP 13. PILOT SPARK TEST.** Visually check for spark at the pilot assembly.

Note: The pilot burner mounts on the left side of the main burner on 970/971 series heaters.

If the igniter is not sparking, check for:

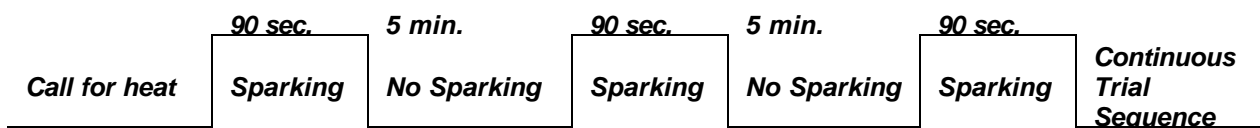
- a 7/64" spark gap
- spark cable continuity
- ground cable continuity

Adjust or replace as needed.

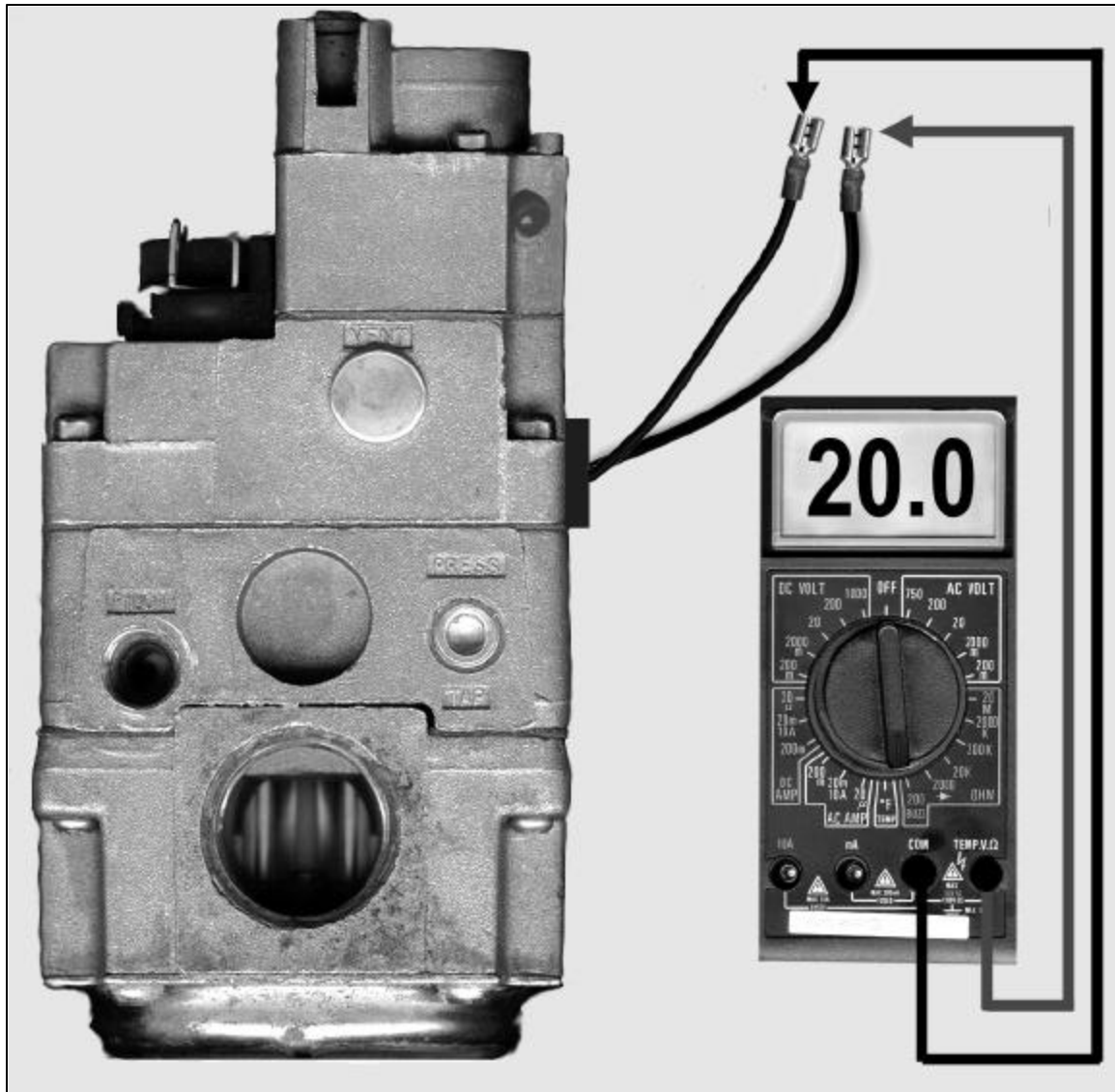
If sparking is present, go to Step 14.

**Power To Module Must Be Interrupted To Reset .**

#### **Trial for Ignition**



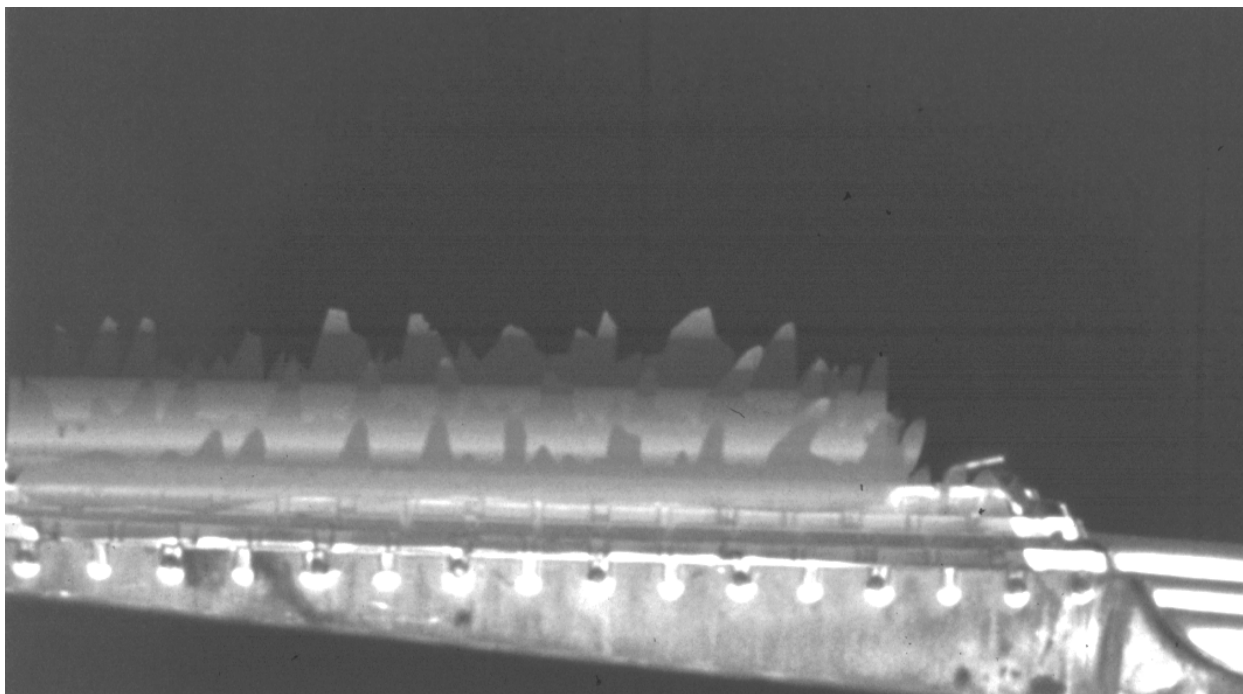
## BTC TANK TYPE HEATERS SERVICE WORKBOOK



**STEP 14. PILOT VALVE - OHM TEST.** If pilot assembly is sparking but no pilot flame is established, disconnect the pilot valve solenoid leads. Using a multimeter, (set to read ohms) test for 20\* ohms resistance +/- 5 through the solenoid coil.

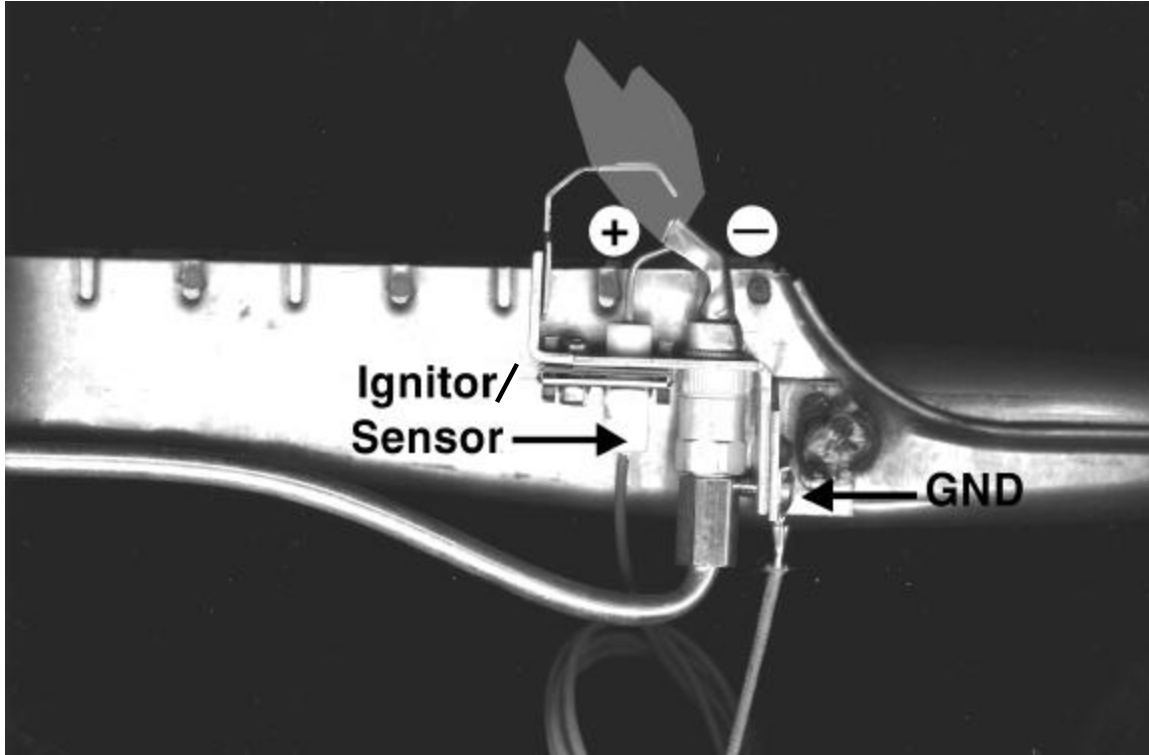
- If the meter does not read 20 ohms plus or minus 5, replace gas valve.
- If the meter does read 20 ohms plus or minus 5, check for:
  - pilot gas - if none, replace gas valve.
  - blockage in pilot tube or orifice - clear blockage and go on to Step 15.

\*BTC 500 - Honeywell Dual Valve check that coil is not open between blue (PV) and white (MV/PV) terminals.



**STEP 15. MAIN BURNER TEST.** Visually check for main burner.

- If the main burner ignites, sequence is complete.
- If the main burner does not ignite, go to Step 16.



## **STEP 16. FLAME RECTIFICATION**

*Note: Flame rectification means that an alternating current (AC) signal is changed to a direct current (DC) signal. The pilot flame is the 'switch' which connects the pilot hood to the igniter and ground. If the pilot hood and igniter sensor had the same surface area, the flame 'switch' would conduct an AC signal. Because the pilot surface is greater than the igniter surface, the signal becomes a DC current that the module can interpret. The pilot hood must be properly grounded and the pilot flame must remain in contact with both surfaces for the flame proving signal to remain constant.*

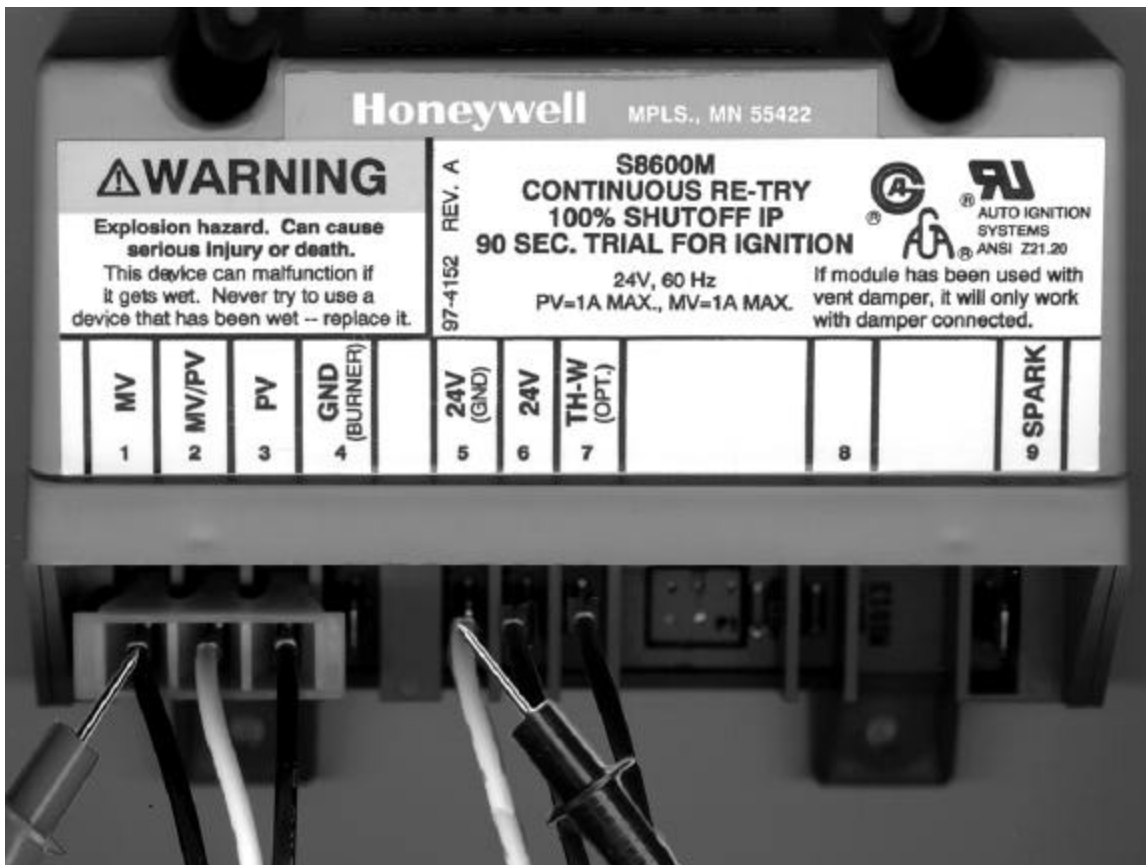
*If the signal is broken for just 8 tenths of a second, the heater will cycle off.*

**Sparking at the pilot will continue if an insufficient signal is received by the module.**

*Sparking at the pilot will stop almost immediately after the ignition module senses the pilot flame.*

## BTC TANK TYPE HEATERS SERVICE WORKBOOK

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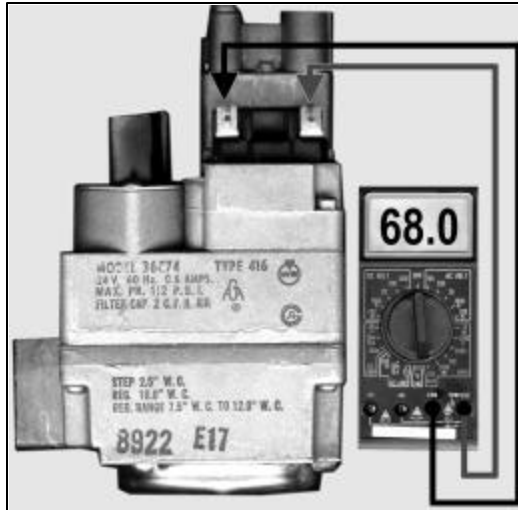
**Pilot is lit - Sparking has stopped.**

**STEP 17. IID MODULE TEST.** Using a multimeter, test for 24 VAC between terminal MV on the IID and 24V (GND).

- If 24 VAC is not present, replace the IID module. Conduct Step 18 before applying power to replacement module.
- If 24 VAC is present, go to Step 18.

## BTC TANK TYPE HEATERS SERVICE WORKBOOK

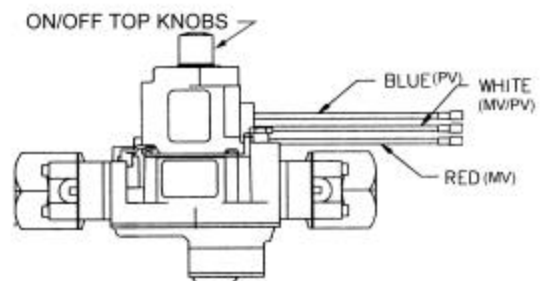
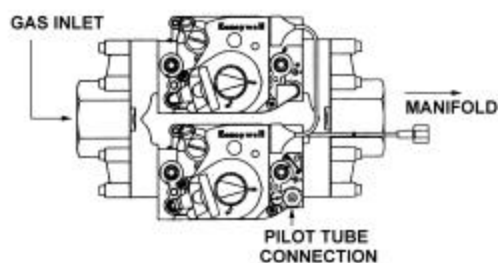
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**STEP 18. MAIN GAS VALVE CHECK.** Disconnect wires from gas valve TH and TR terminals. Using a multimeter, test for 68 ohms plus or minus 5 between TH and TR on the main valve coil.

- If the meter reads 'O' or infinity, replace the gas valve.
- If the meter reads 68\* ohms plus or minus 5, the main burner will ignite.
- 

\*BTC 500 - Honeywell Dual Valve = Check that coil is not open between red (MV) and white (MV/PV) terminals.

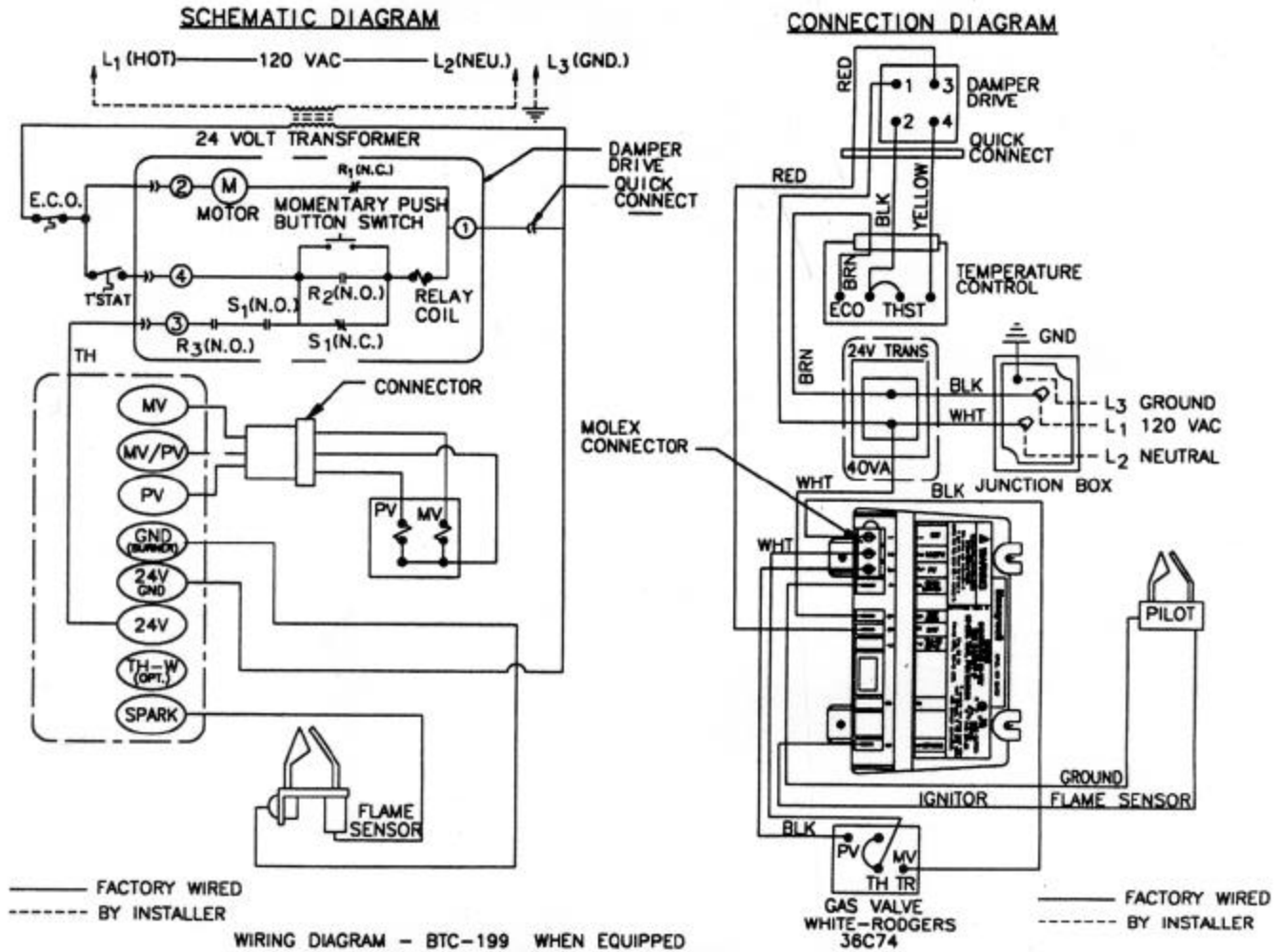


### ALTERNATE BTC-500 GAS VALVE

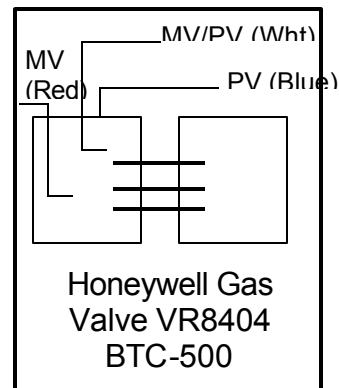
# BTC TANK TYPE HEATERS SERVICE WORKBOOK

## BTC WIRING DIAGRAM - NATURAL AND PROPANE GAS Honeywell Ignition System

### WIRING DIAGRAM



IF ANY OF THE ORIGINAL WIRE AS SUPPLIED MUST BE REPLACED, USE ONLY TYPE 105° C THERMOPLASTIC OR EQUIVALENT.





**BTC TANK TYPE HEATERS  
SERVICE WORKBOOK**

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**GENERAL SERVICE CHART**

CONDITION	CAUSE	SOLUTION
PILOT LIGHTS, SPARK CONTINUOUSLY	PILOT FLAME NOT PROVING	SEE FLAME RECTIFICATION - STEP 16
HEATER WILL NOT IGNITE	NOT PROVING PILOT FLAME EXISTANCE	INTERRUPT 120 VAC POWER . CHECK GROUND WIRE ATTACHMENT  . CLEAN OR REPLACE PILOT ASSEMBLY
	PILOT GAS NOT COMPLETELY INTERRUPTED AT END OF HEATING CYCLE	. CHECK SUPPLY GAS PRESSURE . REPLACE GAS VALVE
WEeping TEMPERATURE AND PRESSURE RELIEF VALVE	THERMAL EXPANSION	ADD THERMAL EXPANSION TANK
PREMATURE TANK LEAKAGE	CONDENSATION	. INCREASE STORED WATER TEMPERATURE AND CONFIRM PROPERLY SIZED APPLICATION
	CONTAMINATED AIR	. REMOVE CONTAMINANTS. . SUPPLY CLEAN COMBUSTION AIR.
	WATER HAMMER	. ADD WATER HAMMER ARRESTOR. . REDUCE WATER PRESSURE. . REMOVE UNNECESSARY CHECK VALVES.
	THERMAL EXPANSION	ADD THERMAL EXPANSION TANK.
	DEPLETED ANODES	SCHEDULE ANODE CHECKS - REPLACE AS NEEDED.

**GENERAL SERVICE CHART (continued)**

**BTC TANK TYPE HEATERS  
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<b>CONDITION</b>	<b>CAUSE</b>	<b>SOLUTION</b>
DAMPER WILL NOT OPEN	BINDING SHAFT	SUPPORT VENTING
	SHAFT SPRING WEAK/BROKEN	REPLACE DAMPER
	DAMPER MOTOR	REPLACE MOTOR
NO SPARK AT PILOT - DAMPER FULLY OPEN	DAMPER ASSEMBLY	REPLACE PC BOARD - SEE STEP 10 Pushing momentary services button may provide a tank of hot water.
	IID MODULE	REPLACE IID STEP 12
	SPARK CABLE	REPLACE CABLE STEP 13

## BTC TANK TYPE HEATERS SERVICE WORKBOOK

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### GENERAL QUESTIONS AND ANSWERS

**Q: How much electrical power is required for a BTC water heater?**

A: The BTC models draw approximately .7 Amps.

**Q: The units require "leg kits" to meet National Sanitation Foundation standards. What are the model numbers for these kits?**

A: The BTC model heaters with 28 inch diameter tanks (BTC 198, 200, 250, 275 and 400) need AOS kit number 192293 "leg extension kit".

A: The BTC model heaters; with 24 inch diameter tanks (all others) need AOS kit number 6569. This kit consists of pt. no. 191037 "vermin guard" and pt. no. 97059-1 "leg cover".

**Q: When should BTCs be delimed?**

Many variables affect the liming up process including:

water temperature - The amount of lime accumulation during the same period of time will be nearly 4 times greater if water is stored at 140 degrees F than at 120 degrees F. a 180 degree setting will build up lime twice as fast as a 140 degree F setting.

volume of water - The more gallons flowing through the BTC, the more rapid the accumulation.

hardness – the harder the water the quicker lime build up occurs. 1 to 3.5 grains per gallon is "soft", 3.5 to 7 grains per gallon is "moderate", 7 to 10.5 grains per gallon is "hard" and 10.5 + grains per gallon is "very hard". (An aspirin is about 5 grains. One grain is equal to 17.1 parts per million.)

A: Deliming should be done when a slight rumbling or popping sound is detected when the main burners are on.

**Q: What effect will lime build-up have on the BTC water heater?**

A: One eighth inch of scale build-up may reduce efficiency as much as 22%; a 1/4 inch build-up, as much as 38%.

A: Less efficient heat transfer means more bottom head expansion/contraction stress and premature leakage.

A: Heavy build-up on the bottom head and bottom portion of the flue pipes leads to more heat transfer at the top of the flues. This can lead to stacking or erratic thermostat operation.

**Q: Anode rods provide additional protection against corrosion. When should these be replaced?**

A: When large gouges or pits appear in the anodes, replace them.

**Q: How often should these anodes be inspected?**

A: Approximately every six months.

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**COMPONENT PART INFORMATION**

	NAME	SPECIFICATIONS
DUAL CONTROLLER	THERMOSTAT	120-180° RANGE, $\pm 4^{\circ}$ , $5^{\circ}$ DIFFERENTIAL, LIQUID FILLED, ANTI- STACKING
	HIGH LIMIT (ECO)	OPENS - 205° FIXED, MANUAL RESET BELOW 185°
GAS VALVE	NATURAL GAS	BTC 120 THRU 250, 275 THRU 400 24 VAC, 60 HZ, .6A; .7 TO 3.5" W.C. STEP
		BTC-400; 24 VAC, 60 HZ, .6A; .8 TO 3.5" W.C. STEP
		BTC-500; 24 VAC, 60 HZ, .7A; STEP OPENING
	PROPANE GAS	BTC 120 THRU 400; 24 VAC, 60 HZ, .6A 2.5 TO 10" W.C. STEP
		BTC 500; 24 VAC, 60 HZ, .7A; STEP OPENING
INTERMITTENT IGNITION DEVICE CONTROL	NATURAL GAS AND PROPANE GAS	24 VAC, 50-60 HZ, .1A; .7 MICROAMP SIGNAL CONTINUOUS RETRIAL
DAMPER	COMPLETE ASSEMBLY	
	MOTOR	24 VAC, 60 HZ, 120 RPM, 5 WATT
	P.C. BOARD W/RELAY	MOMENTARY PUSH BUTTON
TRANSFORMER		120 V PRIMARY, 24 VAC SECONDARY, 40 VA, 50-60 HZ, CLASS 2 "B"

**PRODUCT INFORMATION TABLE**

BTC MODEL	INLET WATER CONNECTIONS			OUTLET WATER CONNECTIONS			TANK CONSTRUCTION AVAILABLE		AVAILABLE	
	Top	Front	Rear	Top	Front	Rear	Standard	ASME	Nat.Gas	Prop.Gas
120 154 179		X X X			X X X		X X X		X X X	X X X
197 199 200 240	X	X X X	X	X	X X X	X	X X X X	X X	X X X	X X 235,000
250 251 275 305	X X	X X X	X X	X X	X X X	X X	X X X X	X X X X	X X X X	X X X
365 400 500	X	X X	X	X	X X	X	X X X	X X X	X X X	X X 480,000

ALL REQUIRE LEG KITS TO MEET NSF REQUIREMENTS.

SERVICE AGENT	_____	INSTALLATION DATE	_____
MODEL NUMBER	_____	SERVICE DATE	_____
SERIAL NUMBER	_____	LOCATION ADDRESS	_____
			_____

**Service Workbook**  
**Training Department**

## BTC TANK TYPE HEATERS SERVICE WORKBOOK

### V. WATER PIPING

Is the system properly sized?	yes	no	
Is the system properly installed?		yes	no
Are there any water leaks?	yes	no	
Does the installation have a recirculating system?	yes	no	
If so, is it operational?		yes	no

### VI. PROPER SEQUENCE OF OPERATION

During standby does damper close on standby?	yes	no	
During standby is pilot flame off?		yes	no
On a call for heat does thermostat close?		yes	no
On a call for heat does damper open completely?	yes	no	
Does sparking begin at pilot?	yes	no	
Is pilot flame established?	yes	no	
If so, does sparking stop?	yes	no	
Does main burner ignite?	yes	no	
Does the thermostat satisfy?	yes	no	
Does damper close?		yes	no

Comments:

### VII. SAFETY

#### A. Gas

Does pilot flame prove before main burner ignites?		yes	no
Does damper blade fully open before ignition sequence occurs?		yes	no
Is burner cover plate in place?	yes	no	
Is burner floor shield in place?	yes	no	
Does IID lockout occur after 30 sec. trial for ignition? (Propane models only)		yes	no

#### B. Water Temperature

Is the thermostat adjusted to the lowest acceptable temperature?		yes	no
Does the installation have a mixing valve?		yes	no
If so, is it operational?		yes	no
What is the outlet temperature of the mixing valve? _____			

**NOTE:** (To minimize the risk of scalding, the manufacturer recommends storing water at 120°F.)

Is a properly rated temperature and pressure relief valve installed?		yes	no
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#### C. Electrical

Is the 120 VAC electrical power supply properly wired?		yes	no
Are all the BTC control covers in place?	yes	no	
Is the 120 VAC electrical power supply properly fused?		yes	no

#### D. Flammables

Are flammable materials located in the area of the water heater?		yes	no
Are flammable vapors located in the area of the water heater?		yes	no

Comments:

(This service checklist may be photo copied to assist with BTC service call.)

**BTC TANK TYPE HEATERS  
SERVICE WORKBOOK**

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**COMMENTS**

[This service checklist may be photo copied to assist with BTC service calls].